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THE TOTAL ECLIPSE OF SEPTEMBER 10, 1923.

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In Popular Astronomy, July 1913, Professor Todd published an interesting article entitled "Three Centuries of Total Eclipses in Mexico", in which he points out that the next total eclipse visible in this country is that of September 10, 1923. As Mexico is the only place on land where it will be seen, the Tacubaya Astronomical Observatory undertook the complete computations of all the elements to obtain the route of the shadow across the republic.

According to these computations the shadow will go around a great part of the Northern Pacific Ocean, beginning at $7^h\ 47^m\ 35^s$ G. M. T. in a place whose coördinates are: latitude $\phi = 48°\ 19'\ 00''$ N. and longitude $\lambda = 205°\ 53'\ 15''$ W.G., nearly south of the Peninsula of Kamchatka; turning to the south, it will enter Lower California at Ensenada de Todos Santos, crossing Mexico diagonally toward the southeast and leaving it at Quintana Roo; the path of totality ends in the Caribbean Sea at $10^h\ 18^m\ 02^s$ G.M.T. in the place $\phi = 13°\ 45'\ 11''$ and $\lambda = 63°\ 59'\ 09''$ W. G., without passing across any important island.

A special publication about it will be issued in due time with a chart showing all the places located within the zone of totality. Meanwhile, I think it will be of interest to give the results of the computations and to show by the chart the places of some importance within the zone: San Diego, California, U. S. A., Guaymas, Hermosillo, Nazas, Cuencamé, Tampico, and Campeche. Unfortunately the best places for observing the eclipse, located in the central plateau at a height 5000 feet above sea level, are small villages.

I should add that the positions of the sun were deduced from Newcomb's Tables and those of the moon from Radau's, and that in the elements of the eclipse the height has not been taken in consideration.

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Total Eclipse of Sun September 10, 1923.

Tables of the Eclipse.

h	x	log x'	y	log y'	μ ° ′ ″
6	−1.365434	9.735086	0.964443	9.227833_n	90 42 19.0
7	−0.822112	9.735114	0.795532	9.228014_n	105 42 36.7
8	−0.278719	9.735129	0 626484	9.228195_n	120 42 54.4
9	+0.264694	9.735130	0.457292	9.228380_n	135 43 12.1
10	+0.808073	9.735116	0.287954	9.228567_n	150 43 29.8
11	+1.351371	9.735091	0.118462	9.228757_n	165 43 45.4

h	d ° ′ ″	Penumbra l_1	Shadow l_2	Shadow tang. f_2	Penumbra tang. f_1
6	5 08 09.5	0.538765	−0.007068	7.664824	7.666936
7	5 07 14.2	0.538733	−0.007105	7.664831	7.666942
8	5 06 18.9	0.538677	−0.007163	7.664837	7.666949
9	5 05 23.6	0.538595	−0.007244	7.664843	7.666955
10	5 04 26.2	0.538489	−0.007349	7.664849	7.666961
11	5 03 32.9	0.538357	−0.007480	7.664856	7.666968

Hourly Coördinates of the Sun and Moon.

h	Sun α' ° ′ ″	Sun δ' ° ′ ″	Moon α ° ′ ″	Moon δ ° ′ ″
6	168 02 01.86	+5 08 17.94	166 39 59.05	+6 05 49.96
7	168 04 16.79	5 07 21.15	167 14 52.93	5 54 52.01
8	168 06 31.72	5 06 24.35	167 49 46.89	5 43 51.46
9	168 08 46.64	5 05 27.54	168 24 40.94	5 32 48.31
10	168 11 01.56	5 04 30.72	168 59 35.10	5 21 42.56
11	168 13 16.49	5 03 33.89	169 34 29.39	5 10 34.21

h	π' ″	S' ′ ″	log R'	π ′ ″	S ′ ″
6	8.729	15 54.29	0.002918	59 53.47	16 20.18
7			0.002921	59 54.77	16 20.53
8			0.002915	59 56.05	16 20.88
9			0.002908	59 57.31	16 21.23
10			0.002902	59 58.55	16 21.56
11			0.002895	59 59.77	16 21.90

Data at Conjunction of Sun and Moon.

Greenwich mean time of ☍ is right ascension: $8^h\ 30^m\ 46^s.4$

	Sun	Moon
Right ascension	$11^h\ 12^m\ 30^s.73$	
Declination	+5° 05′ 55″.21	+5° 38′ 11″.16
Equatorial horizontal parallax	8 .729	59 56 .70
Semidiameter	15 54 .36	16 21 .05
Hourly motion in R. A.	$8^s.99$	$139^s.60$
Hourly motion in Dec.	−56″.81	−11′ 03″.15

SPECIAL ELEMENTS FOR MEXICO.

G.M.T. h	x	y	μ ° ′ ″	d ° ′ ″	l_2
9.0	+0.26469	+0.45729	135 43 12	+5 06 23.6	−0.007244
9.1	0.31904	0.44036	137 13 14	5 18.0	0.007254
9.2	0.37338	0.42342	138 43 16	5 12.5	0.007265
9.3	0.42772	0.40649	140 13 17	5 06.9	0.007275
9.4	0.48206	0.38956	141 43 19	5 01.4	0.007286
9.5	0.53640	0.37262	143 13 21	4 55.9	0.007296
9.6	0.59071	0.35569	144 43 23	4 50.4	0.007307
9.7	0.64505	0.33876	146 13 24	4 44.8	0.007317
9.8	0.69939	0.32182	147 43 26	4 39.3	0.007328
9.9	0.75373	0.30489	149 13 28	4 33.7	0.007332
10.0	0.80807	0.28795	150 43 30	4 28.2	0.007349
10.1	0.86241	0.27100	152 13 32	+5 04 22.7	−0.007362

CENTRALITY CURVE, LIMITS AND DURATION OF TOTALITY.

	Centrality ϕ	Centrality λ W. G.	Duration
h	° ′ ″	° ′ ″	m s
9.0	+32 15 40	117 29 52	3 33.7
9.1	31 03 32	115 22 28	3 31.7
9.2	29 51 19	113 14 40	3 28.8
9.3	28 38 05	111 04 51	3 25.0
9.4	27 24 20	108 51 36	3 20.5
9.5	26 09 39	106 36 05	3 15.0
9.6	24 53 37	104 08 30	3 08.8
9.7	23 36 24	101 30 39	3 01.5
9.8	22 17 28	98 39 16	2 53.0
9.9	20 56 16	95 27 13	2 43.8
10.0	19 31 52	91 44 05	2 33.5
10.1	+18 02 22	87 10 20	2 21.5

	Northern Limit		Southern Limit	
	ϕ	λ	ϕ	λ
h	° ′ ″	° ′ ″	° ′ ″	° ′ ″
9.0	+32 53 05	116 59 50	+31 38 15	117 59 54
9.2	30 28 44	112 42 13	29 13 54	113 47 07
9.4	27 58 54	108 16 55	26 49 46	109 26 17
9.6	25 26 34	103 31 32	24 20 40	104 45 28
9.7	24 09 04	100 52 35	23 03 44	102 08 43
9.8	22 48 31	97 59 21	21 46 25	99 19 11
9.9	21 26 08	94 45 12	20 26 24	96 09 14
10.0	20 00 22	90 58 23	19 03 22	92 29 47
10.05	19 15 36	88 48 12	18 20 16	90 22 44
10.10	+18 29 02	86 20 03	+17 35 42	88 00 38

In the chart (Frontispiece) the figures along the edge of the zone indicate the time of central eclipse in Tacubaya Civil time.

Tacubaya, D. F.,
January 15, 1919.

REPORT ON MARS, No. 21.

WILLIAM H. PICKERING

[*Continued from page 79.*]

The writer makes it a point never to enter a canal or lake on his drawings that he cannot hold in steady vision, either as long as he cares to look at it, or, if the seeing is constantly fluctuating, at least as long as the good seeing lasts, whether that be for a minute, or for only a few seconds. Even supposing that a canal that we only glimpse is really there, it is not worth while recording it, because we cannot see it well enough to be sure of its curvature, direction, or position. If we draw it wrongly, then our observation throws doubt and discredit on the location determined by some other observer who has really seen it in a satisfactory manner.

The fact that a canal is drawn by an accepted observer ought to be sufficient guarantee that it was really there. The confirmation of others should be merely as to its visibility, curvature, etc. A canal that is only glimpsed should not be entered on the visibility scale at all. There are plenty of interesting and surprising phenomena constantly occurring on Mars that we can clearly see, without entering details that we can only glimpse, even if we think they are real. One reason that we find so many straight canals on certain maps of the planet that have been published in the past is that their authors entered everything they could glimpse, whether they really saw it clearly or not. Anything that one can only glimpse he naturally, and properly, enters either as a straight line, or as a circle.

Before leaving the question of the faintness of the canals that should be entered upon our drawings, the writer would again like to state that under no circumstances should a map be taken to the telescope, and canals and lakes that are found upon it hunted up on the planet. While this course of procedure would obviously add materially to the number of canals found, it is considered to be a distinctly objectionable method, for the several reasons given in Report No. 18, 2, POPULAR ASTRONOMY 1917, **25**, 560. We don't want canals on our list that are found that way. The proper method of procedure is to leave all maps entirely out of one's mind, and enter on the drawing only those features that are clearly seen in the telescope.

The writer wishes to say here again what he said before, that there is no such thing as superlative eyesight, as has sometimes been claimed for particular individuals. There is of course bad eyesight, and good

eyesight, but between those who have really good eyesight there is very little to choose. With a little training in their work all persons with good eyesight see just about equally well (See Report No. 11, 10, POPULAR ASTRONOMY 1915, **23**, 578).

Another point illustrated by Table III is that with a really first class observer, the difference between good and only moderate seeing does not make very much difference in the total number of canals detected. We know that the seeing in Arizona is good, and we know that the seeing in England is only moderate at the best, yet the difference between our second and fifth columns is not so very great. It is quite possible, however, that the fifty-ninth canal of the fifth column may be distinctly narrower than the fifty-first canal of the second. But besides good and moderate seeing there is also poor seeing, and there is no question but that with poor seeing, which is very prevalent at times in the north, no canals can be seen at all.

Considering now exclusively the work of the four observers in the first group, we find not only that they all saw about the same number of canals, but also that the canals that they did see were in general the same. Thus there were 33 canals that they all four recorded, or more than half of the whole number seen by any one of them. There were 15 that three of them saw, 18 seen by two, making 66 confirmed canals, and 25 seen only by one, 91 in all. None of them saw more than eight canals which one of the other three could not confirm. Indeed Phillips saw only two unconfirmed canals.

But because a canal is not confirmed, that does not show by any means that it does not exist. It must be remembered that this study is based on only a few selected drawings furnished by each observer. Many unconfirmed canals might be amply confirmed were all the drawings of all the observers consulted. Moreover, it is probable that some canals are very short lived, lasting only a few days,—possibly only a few hours. Therefore unless any two drawings are made at exactly the same time, it is quite possible that one may show a canal not found upon the other. Then too we must consider the possible difference in atmospheric conditions upon the planet when the drawings were made, such as small and invisible Martian clouds, as well as the varying seeing upon our own planet.

As a result of this investigation we find from Table III that the published drawings show 131 different canals, of which 83 were seen by at least two observers. In 1914 the total number seen was 80, confirmed by two observers 45. In 1916 total number 77, confirmed 54. Thus we find a steady increase each year in the number of confirmed canals, and we expect this number to reach its maximum for several years to come at the next apparition. Of the 29 canals taken from Lowell's

various maps, 8 were confirmed by two or more observers, and one was confirmed out of the 5 taken from the map of Jarry-Desloges. This would seem to imply that the additional canals, not shown upon our standard map, are in general either very faint, or else very transient phenomena.

TABLE IV.

PROPORTION OF THE CANALS VISIBLE TO THE DIFFERENT OBSERVERS.

Vis.	Pl.	Pk.	W.	D.	Mg.	Misc.	Total
6	1.00	1.00	1.00	1.00	1.00	1.00	25
5	.85	.77	.85	.92	.85	.77	13
4	.83	.75	.67	.58	.75	.42	12
3	.27	.45	.64	.64	.82	.18	11
2	.09	.36	.32	.36	.73	.14	22
1	.04	.04	.04	.06	.79	.02	48
Total	53	59	60	62	108	46	131

In Table IV the arrangement is similar to that in Table III, except that instead of giving the total number of canals seen by each observer, it gives the proportion of the total number recorded. These total numbers are given in the last column of Table IV, and are taken directly from Table III. As we descend the columns to fainter and fainter canals, the proportion of the total number seen by each observer should gradually decrease, falling off sharply when he approaches his limit, and this we find in general to be the case. We notice by the last column that as the canals grow fainter, they first decrease, and then later increase in numbers. This was noticed also at the last apparition.

MAGNIFICATION. ARYN.

The question of magnification is a very important one in planetary research, and three general results of observation may be laid down in this place. (*a*) As long as we can retain a reasonably distinct image, the more we magnify the more accurately can we measure and draw the various planetary details. Difficult canals are of two kinds, those that are extremely narrow and sharp, and those that are broad but lacking in contrast. (*b*) Within reasonable limits difficult narrow canals are equally well seen with either high or low powers. (*c*) For the broad canals and large lakes lacking in contrast, a low power is desirable,—provided that they are really there. The real question, however, often is, "Are they there?" If they are not, then the user of the high power, although correct in omitting them, appears at a disadvantage as compared to the user of the low power, since he apparently has not been able to detect them.

To take one concrete instance from among several, the canal Boreosyrtis joining Casius to Nilosyrtis was clearly seen in 1916 by Wilson and Douglass, but not by Phillips or the writer (Report No. **17**, figures 21, 22, 23, and 24). This past year Wilson still saw it vaguely, but the others did not. What they saw was a broad well defined area, very dark, but not shaped in the least like a canal. On the other hand Maggini saw it as a narrow curved streak, exactly as it is drawn on the standard map (Report No. **15**), and not at all as it appeared to the others. He used a low power,—only 318. Wilson used magnifications of 211 and 360; the other observers used various powers from 400 to 660 (see Table I). The users of the low powers were of course credited with the canal, but—was it really there?

This question of what we shall call a canal, and what not, is sometimes a very difficult one, notably in region **C**. Should the use of the term depend on the shape of the object only, or should we also fix a limiting breadth? For instance in Figure 10 the broad band stretching westerly from Tithonius along latitude $-10°$, in longitude 115°, has been identified as the canal Eumenides. This is doubtless correct, but what should be done with the still broader parallel band, somewhat farther to the north, and stretching two-thirds way across the disk. It fills practically all the space between Gigas and Acheron. Should it be called a canal, and if so which, or both? In Figure 12 the same band of the same width is shown, but only on the eastern half of the disk. In Figure 9 it is also shown, but within it a narrower darker band appears. In Figure 30 only the narrower band is visible. In Figure 11 a double canal similarly placed, but lying in latitude $+32°$ and $+37°$, has been identified as Acheron and Phlegethon, while in Figure 29 an inclined double canal in latitude $+15°$ and $+ 22°$ has been called Gigas.

These drawings illustrate a typical doubtful case of identification. Is it possible that they are all representations of the same canal? In Figures 10 and 12 high powers of 350, 450, 430, and 660 were employed, in the other four lower powers of 330, 211, 440, 318, and 300. Was it really a broad uniform band as the high powers indicated, or was it of variegated structure with duplications of narrow canals, located in different places and extended in different azimuths, as shown by the lower powers?

Lest an erroneous impression should be produced on those unfamiliar with the planet, it should be stated at once that in the above instance the writer has purposely selected a most difficult example, on the most difficult of the six selected regions of the planet,—region **C**. This region is difficult, and was so in 1914 and 1916, because it shows extremely little contrast, so little in fact that at first sight no detail at

all can be seen upon it, save Acidalium Mare in the north, and possibly Solis Lacus and Tithonius in the south. In the other five regions with reasonably good seeing the detail stands out as clearly as it does on most of the drawings, but in region **C**, if we did not greatly exaggerate the contrast that we actually find, our drawings would be merely blank paper. Indeed this region might almost be taken from another planet, so unlike it is to the other five.

On the Moon it has been found that, with a magnification of 4, certain straight, narrow, dark, canal-like lines are visible, which with a magnification of 12 or greater entirely disappear, or rather, more correctly speaking, present to us then a very different appearance (Report No. **6**). It is possible that something analogous to this structure is to be found on this contrastless face of Mars. At the next apparition the planet will be appreciably nearer to us at this same season of its year, and it is suggested in studying this particular face of the planet, that extremely low powers in addition to the high ones should be used by all the observers, powers such as 200 and 300 for instance. By this means it is possible that some of these radical divergencies of appearance can be assimilated.

It must not be supposed, however, that this now seemingly lifeless, contrastless region of the planet is always a desert waste, and that our standard map representing it as seamed with narrow canals, traversing it in all directions, is hopelessly inaccurate and misleading. This region certainly does convey the impression of a desert waste, or at least of a very uninteresting area, during that portion of the year when the moisture is flowing southerly from the northern polar cap, but when conditions are reversed, and the flow is from the south, innumerable short narrow canals appear, much more numerous than the map indicates, and fully as narrow. This statement is based on drawings made by Professor Douglass and the writer, under very favourable atmospheric conditions, with a 13-inch refractor at Arequipa, Peru, in 1892. An entirely different map is needed for this face of the planet between the September equinox and the December solstice from what would have been suitable at the last three apparitions.

But it is not only in region **C** that marked differences have been detected. The Elysium canals were very much narrower, fainter, and straighter, in 1892, while the Syrtis Minor and Lacus Phoenicis were then conspicuous objects. The point of Aryn scarcely visible, or seen only with difficulty of late years, was a most conspicuous feature at that time, while the canal system to the north of Sabaeus on the contrary was much more difficult of detection. Most of the drawings of

region **A** show Aryn strongly marked this year. Only two notes were received by the writer on the subject. One was from Professor Douglass, who says: "I looked many times to make sure of its visibility. When the seeing was 7 or 8 I could only see it occasionally, but at 8 or 9 on the scale I have used I could see it most of the time, or at least I seem to be confident that I did." The other note from Mr. Wilson says: "I have found Aryn rather difficult. There seems to be considerable shading across it, and only at very good moments could the prongs be seen separately." The writer did not succeed in seeing it at all this year, and indicates that fact in his drawings. In 1916 he suspected it towards the end of the apparition, but never has it been at all comparable of late years to its striking appearance in 1892, when it was fully as marked as in any of the drawings made this past year.

Comparison of the Past Three Apparitions.

Comparing the past year's work with that of the previous apparitions, as described in Reports No. 8 and 17, we notice that the present drawings were made appreciably later in the Martian Calendar year. The earlier observations were all taken between $\odot 5°.5$ and $26°.1$, corresponding on the revised Calendar to between the Martian dates of March 12 and 54. In 1916 the drawings were made between $\odot 44°.2$ and $66°.7$, corresponding to the dates of April 37 and May 31. By Table I the present set of drawings were made between $\odot 80°.3$ and $106°.1$, corresponding to the Martian dates of June 6 and July 6, rather more than one quarter of the year being thus completely covered by the three apparitions. As a result, on comparing the three sets of drawings, we notice that between each set the northern snow cap has appreciably diminished in size. It has turned also more directly towards us. The summer solstice occurred, with $\odot 90°.0$, on the Martian date June 27, which for us was March 24, 1918. In 1914 the central latitude lay between $+2°$ and $+9°$, in 1916 between $+14°$ and $+18°$, and this year between $+21°.5$ and $+22°.8$. The maximum size of the planet in three years was $15''.0$, $13''.9$, and $14''.1$; it was therefore still extremely remote, even when nearest us. At an August opposition it appears almost twice as large.

In Table V are entered the names of all the canals that reached visibility 6 in 1914 and 1918, and all those that reached 5 and 6 in 1916. Since there were but three observers included in 1914, each one counts as two in reckoning the visibility. Of the canals recorded, there were 21 in 1914, 22 in 1916, and 25 in 1918. In a few cases the former identifications have been slightly changed, in order to make the results more strictly comparable for the three years. A number of changes

of visibility will be noted, however; 14 canals have increased since 1914, 8 have diminished, while 14 were of the same visibility at the first and last apparitions. In the case of Cephissus, it was invisible in

TABLE V.

COMPARISON OF THE CHIEF CANALS SEEN IN 1914, 1916, and 1918.

Canal	1914	1916	1918	Canal	1914	1916	1918
Astaboras	0	0	6	Hades	4	5	6
Boreas	6	1	2	Hyblaeus	6	5	6
Boreosyrtis	6	5	2	Indus	4	5	5
Brontes	4	6	5	Nectar	6	4	5
Callirrhoe	6	1	6	Nepenthes	6	5	6
Casius	6	6	6	Nilokeras	6	6	6
Cephissus	0	0	6	Nilosyrtis	6	6	6
Ceraunius	6	6	5	Nilus	2	3	6
Cerberus	6	6	6	Ophir	6	4	6
Chaos	4	2	6	Oxus	2	3	6
Cyclops	2	6	6	Pandora	6	5	4
Daemon	6	3	5	Protonilus	4	6	6
Deuteronilus	6	6	6	Sitacus	4	5	6
Erebus	4	3	6	Styx	6	6	6
Eunostos	6	6	6	Tartarus	6	2	1
Euphrates	4	5	6	Thoth	6	6	6
Gehon	4	4	6	Tithonius	6	0	0
Gigas	6	5	6	Triton	4	5	4

the two earlier years, simply because it was hidden under the snow cap. Pandora and Tartarus are so far south that they were rather difficult the past year. The majority have probably increased in visibility since 1914, but the most notable cases are Astaboras, Cyclops, Nilus, and Oxus. The most noticeable decreases occurred in Boreas, Boreosyrtis, and Tithonius. In 1914 the place of Cyclops was taken in part by Achelous (L), a canal beside it. Tithonius in that year was probably a survival from the southern inundations. Omitting these, the more striking increases occurred in the vicinity of latitude $+30°$, the more striking decreases along latitude $+45°$. It is to be expected that at the next apparition the drying up of the more northern marshes will be still more pronounced.

THE LAKES OF MARS.

In Table VI is given a list of the various lakes identified this past year upon the planet. Ismenius was the only one seen by all six observers. Solis was seen by five. Ellison's telescope was too small, and probably his seeing too poor, to show an object so near the southern limb. The two smaller telescopes in 1916 also missed it. Only five saw Nuba. A portion of its outline is clearly shown in Figure 22,

but since it did not appear any darker than the large dark region to the west of it, identification was not admitted. Of the remaining

TABLE VI.

LAKES IDENTIFIED IN THE DRAWINGS.

No.	Lakes	Pl.	Pk.	W.	D.	Mg.	Misc.	Obs.
1	Acidalius (L)				AB	AB	A	3
2	Aenarium (L)					A		1
3	Alcyonia (L)			C				1
4	Ammonium					D		1
5	Anonum (L)	B				A		2
6	Arethusa		A	A		AF	A	4
7	Arsenius (L)		D			C		2
8	Ascraeus		B			C		2
9	Auri (L)	B			B	BC		3
10	Biblis (L)					C		1
11	Caloe	AEF				F	F	3
12	Castorius	D	D		D			3
13	Casuentus (L)					F		1
14	Charontis			DE	D	DE		3
15	Copais					F		1
16	Cyane (L)					C		1
17	Cyclopum (L)			D		E		2
18	Fortunae (L)					C		1
19	Gordii (L)					C		1
20	Hecates					D		1
21	Hesperidum (L)					E		1
22	Hyperboreas	A	B	B	AB	AF		5
23	Ismenius	AF	AF	A	AF	AF	AF	6
24	Juventae		B					1
25	Lunae			B		BC	M	3
26	Memphidis (JD)					F		1
27	Messies (L)			C	B	BC	B	4
28	Moeris					EF		1
29	Moreh (L)	D	D	D		D		4
30	Morpheos (JD)	E				D		2
31	Niliacus	AB				AB		2
32	Nilus (L)					EF		1
33	Nuba	EF		EF	F	EF	F	5
34	Oxia	B	AB		AB	B		4
35	Palladius (L)					A		1
36	Pambotis	E		E		DE		3
37	Panopis (L)			C				1
38	Phoenicis			C		CD		2
39	Primus (L)					D		1
40	Propontis	D	D	D	D	CD		5
41	Propontis II	D				D		2
42	Pyrea (L(					A		1
43	Rubiginis (L)					B		1
44	Semnon (L)					C		1
45	Siloe			A		AF		2
46	Sirbonis					F		1
47	Sithonius	E				E		2
48	Solis	B	BC	B	BC	C		5
49	Stymphalus					D		1
50	Titanis (L)					E		1
51	Triton					E		1
52	Ulysses (L)					B		1

important lakes Hyperboreas and Propontis were missed by the miscellaneous observers. Tables VII and VIII are arranged precisely like Tables III and IV, and the same remarks apply to them.

Considering now only the four observers in the first group, there were four lakes seen by all of them, namely Hyperboreas, Ismenius, Propontis, and Solis. Four more lakes were seen by three of them, and six additional lakes by two of them, making in all 14 that were confirmed, and fifteen that were seen by only one observer. No observer saw more than six unconfirmed lakes, and Douglass had only one that was not confirmed by one of the others.

TABLE VII.

THE NUMBER OF LAKES RECORDED.

Vis.	Pl.	Pk.	W.	D.	Mg.	Misc.	Total
6	1	1	1	1	1	1	1
5	4	3	4	4	4	1	4
4	2	3	3	2	4	2	4
3	4	1	3	4	6	3	7
2	5	2	3	0	10	0	10
1	0	1	2	0	67	0	70
Total	16	11	16	11	92	7	96
Confirmed	16	10	14	11	25	7	26

In Table IX a comparison is made of the lakes visible at the three apparitions. It is arranged exactly like Table V, except that it contains every lake that was seen by as many as two observers at either apparition. The number confirmed in 1914 was 7; in 1916 it was 12, and in 1918 it reached, as we have seen, 26. The Table contains 32 lakes, of which 6 diminished between 1914 and 1918, 22 increased in visibility and 4 remained unchanged. The three which most notably diminished were Ambrosia, Bathys, and Juventae. The first two are located in the extreme south, and could hardly have been seen had they developed this past year. Of the six that conspicuously increased, Hyperboreas

TABLE VIII.

PROPORTION OF THE LAKES VISIBLE TO THE DIFFERENT OBSERVERS.

Vis.	Pl.	Pk.	W.	D.	Mg.	Misc.	Total
6	1.00	1.00	1.00	1.00	1.00	1.00	1
5	1.00	.75	1.00	1.00	1.00	.25	4
4	.50	.75	.75	.50	1.00	.50	4
3	.57	.14	.43	.57	.86	.43	7
2	.50	.20	.30	.00	1.00	.00	10
1	.00	.01	.03	.00	.96	.00	70
Total	16	11	16	11	92	7	96

was covered by the snow cap in 1914 and 1916. The others, Arethusa, Castorius, Moreh, Oxia, and Pambotis ranged in latitude from +60° for Arethusa, to the equator for Pambotis, and they clearly increased

TABLE IX.

COMPARISON OF THE CHIEF LAKES SEEN IN 1914, 1916, AND 1918.

Lake	1914	1916	1918	Lake	1914	1916	1918
Acidalius (L)	2	1	3	Lunae		5	3
Ambrosia (L)	4			Messeis (L)	2	3	4
Anonum (L)	2		2	Moreh (L)	2		4
Arethusa		1	4	Morpheos (JD)		1	2
Arsenius (L)			2	Niliacus	2	4	2
Ascraeus		1	2	Nuba	4	4	5
Auri (L)	4		3	Orontes (JD)		2	
Bathys (L)	4			Oxia		1	4
Caloe	2	3	3	Pambotis		1	3
Castorius		1	3	Phoenicis		1	2
Charontis	4	4	3	Propontis	2	1	5
Cyclopum (L)		1	2	Propontis II		1	2
Hecates		2	1	Siloe		2	2
Hyperboreas			5	Sithonius			2
Ismenius	2	5	6	Solis	6	4	5
Juventae	4		1	Triviae (L)		2	

in visibility on account of the general precipitation. Probably at the next apparition the more southerly ones will have begun to diminish again. On the whole their development seems to follow, rather than precede that of the canals, so that still more may be expected to be visible in 1920.

TABLE X.

THE DOUBLE CANALS.

Canal	W.	D.	Mg.	Canal	W.	D.	Mg.
Acheron	C			Gehon			A
Aesacus	E			Gigas			C
Alander	C			Hiddekel			A
Astaboras		1		Iris	C		
Boreas			D	Jamuna			AB
Casius	F			Jordanis			A
Ceraunius	C			Nilosyrtis	F		
Cerberus	E		DE	Phison		1	A
Cydnus			A	Phlegethon	C		
Daemon	C			Protonilus	1		
Deuteronilus	1			Pyramus			E
Draco	C			Sitacus			F
Erebus			D	Styx	E		
Euphrates	1	1		Thoth I	F		
Eurotas			C	Thotn II			F
Fortuna			C	Ulysses			C
Ganges			B	Uranius			C

The Double Canals.

In the first column of Table X are given the names of all the canals that were recorded as double at the past apparition, 34 in all. The three following columns indicate the corresponding drawings for each of the three observers who were successful in seeing them. The "l" indicates that the duplication is not shown in any of the drawings, but was described in a letter to the writer.

By consulting the map we shall see that the duplications lie in all azimuths, and occur in canals of all degrees of visibility. Wilson saw 16 duplications in 60 canals, or 27 per cent. Douglass saw 3 duplications in 62 canals, or 5 per cent, Maggini saw 18 duplications in 108 canals, or 17 per cent. The late Dr. Lowell used to claim that about 25 per cent of the canals could be doubled by a good observer (Lowell Bulletin No. 15).

Wilson and Maggini, the two most successful observers, recorded 49 canals in common. Of these Wilson succeeded in doubling 11, and Maggini 9. If the phenomenon observed was a real characteristic of these canals, we should expect that 4 or 5 of them at least would be seen double by both observers. In point of fact they only agree upon one canal, Cerberus, and that was one of the least obvious of Wilson's 11. The remaining 18 canals are considered to be double by one observer, and single by the other. Now suppose that we put the names of these 49 canals in each of two separate bags, and give them to the observers. Let Wilson be allowed to draw 11 names from his bag, and Maggini 9 from his. It would then be an even chance that they would have drawn the names of as many as two canals in common. On the planet they only secured one, or less even than chance should have given them. Douglass agreed with Wilson that Euphrates was double, he agreed with Maggini on the duplication of Phison, he found Astaboras double, which neither of the others admitted, but he detected no evidence whatever of duplication in the case of Cerberus.

It would appear that these three observers have made a very valuable contribution to our knowledge of the double canals. The writer did not look for the duplication himself this past year, because he was convinced that it was merely a subjective phenomenon, dependent in the case of the distinct canals on contrast with a bright background, and in the others on varying refraction due to wave motion in our own atmosphere, quite similar to that which produced the well known shadow bands at the time of a total solar eclipse. For experimental evidence on this last matter, see Harvard Annals 18 95-98. Dr. Lowell was a very successful observer of the phenomenon, and since he found the sharply curved Nepenthes double among other canals, it is quite

possible that some of the many fine lines that he detected in Saturn's rings, and which have not been seen by other observers, nor found when Saturn recently transited a star, may have been due to this same cause.

The phenomenon has more of physiological than of astronomical interest, but it should be well seen at this next apparition, and for those wishing to observe it, we cannot perhaps do better than quote two paragraphs from a letter lately received from Mr. Wilson. "The more widely separated double canals I have held steadily under good seeing, (8 and 9 on the standard scale). However, the Euphrates, as I think I have identified it, appears double on the drawings made when the best seeing prevailed (9 and 10). I caught it only in about one or two glimpses a minute." "The phenomenon of the more fine doubles lasts but an instant as double, and I am not sure that some illusion is not prevalent, at least as far as my vision is concerned. The Protonilus Deuteronilus was always seen double during my 1918 observations, when the seeing was as good as 8, though in spots there seemed to be an intermediate shading." These paragraphs may be compared with the writer's description of the doubling of Thoth Nepenthes in 1914, and of Protonilus Deuteronilus as he saw it in 1916 (Reports No. 5 and 16).

Mandeville, Jamaica, B. W. I.
Nov. 8, 1918.

THE MILKY WAY.

(*Bertha Ten Eyck James, our youngest contrib.*)

When the stars like jewels were cut and set
In the arch of chameleon sky,
Up from the floods of sunrise
A lady came wandering by.

She dipped her fingers in star dust,
They were rosy with the day,
And trailed them across the heavens:
Men called it the Milky Way.

From the "Linotype Column" Chicago Tribune.

TWENTY-SECOND MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY.

[*Continued from page 101.*]

SOME SPECTROSCOPIC RESULTS OF THE LOWELL OBSERVATORY ECLIPSE EXPEDITION.

By V. M. Slipher.

Major Guy Lowell, Trustee of the Lowell Observatory, early suggested that the Observatory should undertake observations of the solar eclipse of June 8, 1918, and took keen interest in and assisted with the plans until December 1917 when, in response to our government's call, he went to Europe on a war mission. Mrs. Percival Lowell at all times most generously provided for the expedition in every way and was always helpful by suggestions and encouragment throughout the undertaking.

A full account of the expedition covering the work undertaken and a discussion of the results obtained will be published by the Observatory in the near future.

At this time, on another page, some of the direct photographic results secured by Messrs. C. O. Lampland and E. C. Slipher—assisted by Mrs. Lampland, Mrs. Truman, Mr. Sykes and Mr. Mills,—are presented by them; and hereunder some spectrographic results are given which the writer, with the valuable assistance of Mr. O. H. Truman and Mrs. Slipher, secured.

Slides of the spectrograms were exhibited at the meeting as follows:

I. The continuous spectrum of the inner corona from near λ 3650 to λ 5900 and at least two coronal emission lines, those at λ 5303 and λ 4231, were recorded by a single-prism spectrograph, on a Cramer Isochromatic plate. On this plate the spectrum of the corona extended farther on the east side of the sun, to a distance of half the sun's diameter. The exposure ended very near time of third contact and the brightest flash lines show, as of course do a great many prominence lines of calcium, hydrogen and helium. The intensity of the prominence light and the scattering of it by the veil of cloud over the sun is doubtless sufficient explanation for the lines of calcium, hydrogen and

helium extending across the disk of the moon. Those of calcium extend fully a solar diameter above the sun's surface.

II. Another single-prism instrument of greater light-power gave a record of the corona spectrum to considerably greater distances from the sun's surface. It showed the wide extension of the green coronal line, as well as of those of hydrogen and calcium. This plate also records the dark line spectrum of the corona which the continuous spectrum of the inner corona gives way to as the distance above sun's surface increases.

III. Another spectrogram made with three-prism dispersion and a short camera recorded the hydrogen lines $H\alpha$, $H\beta$ and $H\gamma$, the stronger helium lines of the region and the coronal line in the green (λ5303), as well as a few of the strongest flash lines of the region covered.

IV. A battery of three-prisms was used in the slit-less form for recording the green coronal ring, that of helium D_3 and $H\beta$. The distribution of the coronal material, though showing many local variations is generally about equally abundant for about 90° along the east and west limbs of the sun, rather suddenly falls off and is less in higher latitudes and about the poles. The irregularities of the green ring do not fit those of the hydrogen or helium rings, implying no vital relation of coronal material and prominences.

THE SPECTRA OF TWO VARIABLE NEBULAE: A NEW TYPE OF NEBULAR SPECTRUM.

By V. M. Slipher.

Hubble's Variable Nebula, N. G. C. 2261, it will be recalled, is comet-shaped and has its nucleus at its apex and the nucleus is the variable star R Monocerotis. Two spectrograms have been secured here of this object with the slit of the spectrograph over the nucleus and the axis of symmetry of the nebulosity. Thus the spectrum of the nebulosity and the nucleus are side by side on the plate. The observations disclose the fact that the spectrum of the nucleus and of the nebulosity are alike and peculiar. It is indeed remarkable that the type of the spectrum of this interesting object is that possessed by the temporary star soon after maximum luminosity. A slide exhibited the correspondence of the wave-lengths of the details in this spectrum and those observed by Campbell and Sidgreaves in the spectrum of Nova Aurigae. Another slide showed this in a more objective way by giving side by side the spectrum of the variable nebula and the spectrum of this Nova as photographed by Campbell.

The one other similar variable nebula, N. G. C. 6729, which, as shown by the observations of Knox-Shaw at Helwan and the extensive ones by Lampland at this Observatory, resembles in every known respect Hubble's Variable Nebula, has been spectrographically observed here, although its very low southern declination makes it a very difficult object. As was to be expected its spectrum turned out to be similar to the northern object.

That the spectra of both these singular objects, which are each the product of the close association of a star and a nebula, are the same as the spectrum of the typical temporary star will doubtless seem strong evidence for the view that the temporary star results from the impact of a star and nebula.

WAR TIME INSTRUCTION AT THE HARVARD ASTRONOMICAL LABORATORY.

By Harlan True Stetson.

The program of instruction in astronomy at Harvard during the year 1917-1918 has been one of coöperation with the war aims of the University. The unusually good equipment of the Astronomical Laboratory for instruction in nautical astronomy has resulted in the organization of classes for the training of prospective officers for line duties in the navy. Courses in seamanship, ordnance, and naval science were taught by naval officers detailed by the government, and the department of astronomy assumed responsibility for the training in navigation of some forty students of Harvard who were enlisted men fitting themselves for ensigns' commissions. In addition to the usual courses in practical astronomy as applied to navigation and exploration a full year course in navigation and nautical astronomy was provided.

As instruction in astronomy at Harvard has always emphasized the laboratory method, so to supplement the theoretical work of the lecture room a new departure was taken in the organization of laboratory work in navigation, including exercises in the construction and use of charts of different projections, the laying of courses, study of sea coast lights, the swinging of miniature ships specially constructed in the instrument shop for a careful study of the theory of compass deviations, problems in dead reckoning, current sailing, the adjustment and testing of sextants, and much practice in the use of the sextant in determining latitude, longitude, and compass error from observations from the "bridge" on the roof of the laboratory. Through the generosity of a Harvard alumnus, the "Adventuress", a schooner yacht with

auxiliary power, afforded the requisite means for observations afloat after the completion of the training course of the class room. In such ways has the Astronomical Laboratory been endeavoring to help meet the needs of the present emergency when ships and the manning and navigation of ships have been among the first demands of the year.

PRELIMINARY NOTE ON THE UNIFORMITY OF FILM SENSITIVITY OF PHOTOGRAPHIC PLATES FROM MEASUREMENTS WITH THE THERMO-ELECTRIC PHOTOMETER.

By Harlan True Stetson.

The paper was in the nature of a brief report of progress in work with the "thermo-electric photometer" previously described at earlier meetings of the Society.

The problem of the degree of uniformity in the sensitiveness of a photographic film of a given plate has been one of wide interest to astronomers engaged in photographic photometry. Although some work has been done at times in this connection, conflicting data have left considerable uncertainty as to the magnitude of the error to be reckoned with in this regard. As the thermo-electric photometer has proved capable of measuring the photographic images of stars in focus to an accuracy of one one-hundredth of a magnitude so far as the measurement of the image is concerned, it appeared well worth while to attempt an investigation of the magnitude of errors of the plate due to lack of uniformity in the film in different parts of the same plate. So far only 4x5 Seed plates "27" and "30" have been studied.

Artificial star images have been imprinted on a plate in rapid succession by exposures through a lens to a pin-hole source illuminated by a constant voltage incandescent lamp—the exposure being automatically controlled by a pendulum shutter specially constructed to avoid sources of error due to lack of isochronism.

Plates so exposed have been measured with the thermo-electric photometer and indicate much greater differences in the "apparent" magnitudes of several star images than was anticipated. The region of most plates within two centimeters of the edge has appeared unreliable to perhaps a half a magnitude and the remainder of the plate show variations of tenths of magnitudes where we had hoped for hundredths. As a fully satisfactory method of imposing a scale of magnitudes has not yet been worked out in connection with the method of exposure, these results must be open to modification as investigation continues. However it seems fair to predict from these

preliminary considerations that the ordinary commercial plate is perhaps the source of larger errors of the kind here considered than we had hitherto been led to suppose.

POSITION OF NOVA AQUILAE No. 3.

By R. M. Stewart.

Following are positions of Nova Aquilae No. 3 observed with the Ottawa meridian circle, reduced to 1918.0 and referred to Boss's system:

Date	R. A.	Dec.
	h m s	° ′ ″
1918 June 9	18 44 43.53	0 29 29.5
10	43.46	29.4
18	43.53	29.8
July 4	43.47	29.8
18	43.51	29.3
25	43.49	29.8
30	43.50	30.3
Mean	18 44 43.50 ±0.007	0 29 29.7 ± 0.9

The corresponding position for 1900.0 is

R. A.	= 18 43 48.39	Dec.	= 0 28 20.4
Ann. prec.	= + 3.0615		+ 3.808
Sec. var.	= − .0005		+ .437

ON THE CONSTRUCTION OF HIGH-LEVEL LABORATORIES FOR SCIENTIFC RESEARCH.

By David Todd.

Among the highest mountains heretofore occupied for research purposes (though only temporarily) are:—

Pike's Peak, Colorado	14,000 ft.
Mt. Whitney, California	15,000 ft.
Mt. Blanc, Switzerland	16,000 ft.
El Misti, Peru	19,000 ft.

Permanent occupation of even these heights, although greatly desired, has so far been found wholly infeasible because of the rarefied air. But the experiments of the writer in 1907 at Cerro de Pasco, Peru (elevation 14,000 ft.) in steel compartments filled with air compressed to sea-level tension, have shown the entire practicability of maintaining human life in safety and comfort at any attainable height.

Chimborazo, Ecuador, is chosen for the projected laboratories and observatory because:—

(1) Its position virtually on the earth's equator makes it the best spot for continued observations of all the planets, and of all the stars in both the northern and southern heavens.

(2) Recent completion of the railway from sea-level at Guayquil to Quito, passing over a saddle of Chimborazo at Urbina (12,000 ft.) renders the great mountain already accessible.

(3) Chimborazo's vertical height of four miles (21,300 ft.) is exactly that most desired by meteorologists in those studies of great atmospheric currents essential in improving present means of predicting the weather.

(4) Chimborazo is regarded by experts as free from likelihood of volcanic disturbance. Edward Whymper, in his "Travels amongst the Great Andes of the Equator" (Scribners 1892), page 337, says, "There are no records of eruptions of Chimborazo. It must have been an extinct volcano for many ages. The complete burial of its crater, the thickness of the ice-cap at its summit and large size of its glaciers, the ruin and erosion of its lava streams, and the height vegetation has attained upon its flanks are all indications that its activity ceased at a remote period." Besides this, the neighboring craters of Sangai and Cotopaxi, in frequent eruption, undoubtedly provide the necessary geological safety-valve for this region of the Andes.

(5) The elevation of Chimborazo's summit corresponds to that indicated by Sir Isaac Newton, two centuries and a half ago, and strongly confirmed by modern research, as best for astronomical observation of every type.

Among other sciences that would be most advantaged by such an observatory are meteorology, terrestrial physics, and physiology.

The greatest obstacle to present progress of astronomy is the quivering and unsteadiness of the lowest four miles of the atmosphere, which seem to blur and vibrate all the celestial bodies, much as if they were seen through running water.

To instance a single branch of astronomical work: the finest photographs of the planet Mars so far obtainable are not much larger than the section of an ordinary lead-pencil; while from the unique location of the projected observatory, photographs of this planet could no doubt be obtained as large as a half dollar. Also every department of exact astronomy in which measurements of precision are essential would be immensely benefitted. Not to go farther into details, the enhancement of astronomical opportunity which may conservatively be anticipated from the foundation and maintenance of such an observatory is comparable to the advance of the telephone over the telegraph and the messenger-boy.

Accompanying were photographs exhibiting the general characteristics of this region of Ecuador; also engineer's plans showing the project in outline; with letters bearing on the desirability of such an observatory, and partial estimates for its practical construction.

All mechanical and other details of using astronomical instruments from within the summit chambers under air pressure have been completely worked out with the approval of expert engineers. Entrance into and exit from the chambers is effected by means of automatic safety air-locks, now in general use in caisson engineering.

With regard to permanent maintenance of such an observatory, it would in my judgment be best accomplished in conjunction with some well-known university; and I heartily agree with President Harman that "it would be impossible for any university or individual to erect a greater monument than by building a complete observatory on the top of Chimborazo."

THE POSITION AND PROPER MOTION OF NOVA AQUILAE No. 3.

By Robert Trümpler.

The material used for a determination of the proper motion of Nova Aquilae No. 3 consists in two measures of the Nova given in the Astrographic Catalogue Zone Algiers for 1892 and 1895, two plates taken in 1914 with the 3-inch doublet camera of the Allegheny Observatory, and one plate taken with the 30-inch refractor shortly after the outburst of the Nova.

Magnitude estimates of the Nova and comparison stars on the four plates taken prior to the outbreak of the Nova gave the following results for the *photographic magnitude* of the Nova in the system of the Harvard North Polar Sequence:

1892 Aug. 13	phtgr. magn.	11.1
1895 June 26	"	10.6
1914 June 1	"	11.5
1914 June 24	"	11.5

The relative proper motion of the Nova with reference to ten comparison stars of the mean photographic magnitude 11.7 is found to be:

$$\mu_\alpha = +\,0^s.0003 \qquad \mu_\delta = -\,0''.004$$

For seven stars surrounding the Nova the position and proper motions in the system of Boss' Preliminary General Catalogue have been determined from all observations available. These comparison stars have been used to reduce the photographic measures of the Nova on

Boss's system and to obtain the following mean position and absolute proper motion of the Nova in the system of Boss' Preliminary General Catalogue for the epoch and equinox 1900.0:

$$\alpha = 18^h\ 43^m\ 48^s.381 \qquad \delta = +\ 0^\circ\ 28'\ 20''.62 \qquad \text{p. e.} \pm 0''.08$$

$\mu_\alpha = -\ 0^s.0003$, $\mu_\delta = -\ 0''.018$, or $\mu = 0''.0185$ in position angle $194^\circ.0$, p. e. $\pm 0''.007$.

The proper motion of the Nova differs very little from the mean motion of the stars surrounding it, which are of the same brightness as the Nova had before its outbreak, and it indicates for the Nova a hypothetical parallax of $0''.005$. The Nova would then have increased from a star of about the same luminosity as the sun to one a hundred thousand times more luminous at its maximum.

THE LUMINIFEROUS ETHER—ITS RELATION TO THE ELECTRON AND TO A UNIVERSAL ATMOSPHERE.

By Frank W. Very.

For many years I have been studying the atmospheres of the earth and sun, first by the experimental method and then to some extent as to theory. It was natural that I should pass to the consideration of a universal atmosphere, finding everywhere evidence of its existence, although it is not to be confounded, as was formerly supposed, with the luminiferous ether. It is necessary to modify extensively the ideas which have hitherto prevailed on this subject.

In brief, the evidence points to a universal atmosphere which is the source of magnetism and gravitation by means of vortical spin and oscillatory vibration respectively. Though devoid of gravitative mass, the universal atmosphere, or aura, is both substantial and the *only* substance in nature, since all material entities are formed from it by motion induced by Influx from a Supreme Source of Energy which is indestructible because of its Divine origin.

The fundamental material unit is the electron, which is formed out of the aura by vortical motion. The surface of the electron is supposed to be rotating at all points with the velocity of light, and it is incapable of any further condensation, because this would necessitate a still greater superficial velocity which, as Fessenden has suggested, would involve a pressure exceeding the breaking strength of the medium. The form of the electron arises from this condition of uniform and maximum surface velocity.

By its motion, the electron attaches to itself, or condenses around itself, a shell, or electronic "atmosphere", which shares its motion, but is flung off by any sudden shock which reverses the electron's spin.

When this occurs, the electronic shell, ceasing to rotate, has its previous rotary velocity converted into a rectilinear progressive velocity at the same speed, and thenceforth advances as a spherical oscillatory "ether" particle, or "light-quantum," each particle carrying with it a special electro-magnetic field. Calling the direction of advance the polar axis of the particle, the oscillation is meridional. The luminous intensity is proportional to the number of ether-particles in unit volume, and through the interpenetration of the extended magnetic fields which accompany them, it is possible to have interference of light and other optical effects.

Though far less massive than the electron, the ether-particle, to a limited extent, shares with it the properties of mass and inertia, and can convey momentum. Its inertia, however, is that of its reciprocating magnetic field, while that of the electron comes from its own gyrostatic spin. The advancing pole of an ether-particle draws in the aura and the structure progresses as a momentary "flick" in the medium. Similarly, the electron has indrawing and outflowing poles, and the indrawing poles point outwardly in a positive electric charge upon a solid body, while presentation of the outflowing poles constitutes a negative charge.

WHAT IS THE BEARING OF THE HYPOTHESIS OF A GRAVITATIONAL LIMIT ON THE CURRENT RELATIVITY DISCUSSION?

By Frank W. Very.

The relativity doctrine is a result of the recognition that light is not an elastic wave-motion of a universal ether, but consists of discrete widely separated centers of luminous energy whose particles vibrate singly. The "luminiferous ether," considered as a universal interstellar medium, has therefore been abandoned.

Nevertheless, gravitation and magnetism demand some such medium for their explanation, though one which differs in many ways from the old conception, and this limits the applicability of the relativity principle. The change in the frequency of the electronic vibrations according to the gravitational field in which the light is emitted, which is predicted by the relativity doctrine, has not been found. St. John's work gives a change which is certainly less than 0.002 A, whereas the theory demands a change of 0.008 A. Consequently St. John's measurements favor the doctrine that there is a universal medium, or aura, in which gravitation resides, and that the motions of the electrons are gravitationally relative to the entire galactic body of aura, and not to the limited portions attached to either sun or earth. The relations of

light to electric and magnetic phenomena, which are discussed in this paper, do not seem to require more than a limited application of the relativity principle.

THE WASTING OF STELLAR SUBSTANCE.

By Frank W. Very.

In 1906 I formed the conception that the atoms from helium to manganese may have been formed out of three substances having atomic weights in the ratio of 1:2:4, possibly hydrogen, helium, and an unknown substance, X, of weight 2; and that the valency depends on the number of atoms of X which enter into the composite atom. The next year J. J. Thomson found that positive rays of electricity consist of particles having precisely this ratio of masses, no matter what the gas may be in the vacuum-tube. This seemed to me to lend confirmation to the hypothesis, since electric analysis may be expected to reverse synthesis. If we suppose that nebulium is the substance X, the gaseous nebulae whose spectra chiefly consist of the lines of hydrogen, nebulium and helium, are the synthetic laboratories where matter originates. Somewhere else we should look for a tearing down of atomic structure.

Stellar evolution is first accomplished through the production of atoms of greater and greater complexity; but this is succeeded by stages in which these heavier atoms break up and release their heat of formation. Since momentum equals mass into velocity, any loss of stellar mass will be accompanied by increase of velocity. In confirmation of the reality of the waning of stellar power through destruction of atomic substances, appeal may be made to the statistical compilation by Adams and Strömberg which shows for stars of F to G and K to M types an increase of velocity of 1.5 km per sec. for each diminution of one magnitude in the absolute magnitudes. If the A and B stars are also included, as in a list of 500 stars by Adams and Joy, I find that the change is somewhat smaller, or about 1.0 km per magnitude. A plotting of these observations shows a concentration of the brightest absolute magnitudes in the central (?) galactic condensations and a vague representation of two spiral streams (4½ magnitudes apart, the more distant stream being probably confined to the brighter stars, which are the only ones bright enough for observation) emanating therefrom, whose velocities increase with distance from the supposed center. We may infer that the dwarf stars are more numerous near the distal extremities of the spirals, that they have emanated from the center, that they were once giant stars, or at least were much more massive than at present, and that their waning has gone on *pari passu* with a wasting of stellar substance and an increase of velocity.

GALATIC AND ATOMIC VORTICES.

By Frank W. Very.

A comparison between the structure of an atom, which may be shown to be a complex electronic vortex, and that of star clusters and spiral nebulae, shows that the latter resemble gigantic "vortex-atoms" in some respects, with stars instead of electrons, but that there are also important differences. The facts of stereochemistry and crystallography show that the atoms of solid bodies are spheres in close geometrical piling. The condensation in the atom is superficial, instead of central as in the star-cluster. The only possibility of a "Saturnian" atom is in the gaseous state.

ON NIPHER'S "GRAVITATIONAL" EXPERIMENT AND THE ANOMALIES OF THE MOON'S MOTION.

By Frank W. Very.

Nipher has shown that electric charges slowly penetrate into the substance of the leaden spheres of a Cavendish apparatus, producing a repulsion which is of the same order as their gravitational attraction, and this no matter whether the electricity be positive or negative. After equilibrium is attained, an exhibition of the opposite sort of electricity penetrates most rapidly into the substance of the smaller spheres and reverses their electric sign first, when, for a time, there may be electric attraction, or at least a progressively diminishing repulsion between the large and small spheres; but when saturation is reached, the spheres repel each other as before.

This suggests that electrons thrown off from the sun penetrate into the outer layers of the earth and the moon—a penetration which is great enough at times to produce violent magnetic storms—and that this accession of electrons during long intervals of time may produce a cumulative effect and a variable electrostatic repulsion of a minute amount between the two bodies which is sufficient to account for some of the unexplained anomalies in the moon's motion. It is a misnomer, however, to call the effect, as Nipher does, a "gravitational" repulsion.

THE PROBABLE ERROR OF RADIAL VELOCITIES DETERMINED WITH THE ONE-PRISM SPECTROGRAPH OF THE DOMINION ASTROPHYSICAL OBSERVATORY.

By R. K. Young.

The one-prism spectrograph attached to the 72-inch reflecting telescope of the Dominion Astrophysical Observatory, Victoria, has been in

regular use since May the eighth, just a few days over two and a half months. In that time it has been employed on 42 nights or part nights and four hundred spectrograms of stars (average magnitude 6.0) have been obtained.

Of these spectrograms only one hundred have been measured, and 66 can be used to determine the agreement of the measures with one another and with determinations made at other observatories. From 46 plates of 8 stars, types F8 to Ma, measured with the Hartmann comparator, a probable error of 0.80 km was obtained. For 16 plates of 4 stars, (sixteen lines on the average on a plate), measured with the Toepfer engine, the resulting probable error was 1.19 km.

Twenty-nine plates of 14 stars, types F8 to Ma, whose velocities have been determined at the Lick Observatory, yield a difference, Lick —D.A.O., +0.80 km per second. From 26 stars (F-M types) Mt. Wilson found Lick—Mt. Wilson, + 1.0 km.

PRELIMINARY NOTE ON AN ANNUAL TERM IN THE RIGHT ASCENSIONS.

By Meade L. Zimmer.

In the course of reduction of the fundamental observations begun in January 1913 at Cordoba a curious phenomena was evidenced. Clock corrections obtained in the evening at or near the vernal equinox were uniformly larger by $0^s.07$ or $0^s.08$ than those found from the corresponding morning observations. From comparisons made with the observations taken at the autumnal equinox, it is shown that not more than half this was due to existing periodic errors in Boss' Preliminary General Catalogue, as the difference now became zero.

To investigate the phenomenon two groups of about forty stars each, with mean right ascensions of 6^h and 18^h, were selected. Observations were begun in March 1917 and continued through three successive equinoxes. It was planned to take at least sixteen observations of each star at each equinox, distributed equally as to clamp, and symmetrically with respect to sunrise and sunset.

Without a single exception the clock correction derived from evening observations differs systematically from the morning group. If the March and September results are differenced the effect is striking. This effect does not seem to be due to variation in the clock rate. It is also noteworthy that the difference between March and September observations is not of the same order for all stars. There is little if any dependence on spectral type, proper motion, or declination; but there does seem to be a slight dependence on right ascension, magnitude, and galactic latitude.

All attempts to explain this phenomenon on physical, physiological, or psychological grounds have failed, unless it is due to parallactic effect. But such parallaxes as would be required to account for the phenomenon are inadmissible according to present ideas.

That some part of this effect is due to parallax seems certain. It is probable that it has been instrumental in introducing the periodic errors in star catalogs.

In harmony with these results Chandler pointed out that the z-term in the latitude variation may be caused by parallactic displacement.

Strömberg's conclusion that for stars of small proper motion the parallaxes are independent of proper motion is also in harmony with these results.

REPORTS OF COMMITTEES.

REPORT OF THE COMMITTEE ON VARIABLE STARS.

By William Tyler Olcott, Chairman.

In spite of the distracting influences of war, the work of variable star observing has gone forward uninterruptedly notwithstanding the fact that many observers, both professional and amateur, have joined the colors, or are otherwise engaged in war work.

The value of coöperation has been strongly evidenced during the past year, especially so in the case of the regular observation of long period variables. The aid rendered by the observers in the southern hemisphere is the most encouraging feature of this plan, observations now being contributed regularly from South Africa, South America, and New Zealand. If this can be maintained for several years to come our knowledge concerning the southern variables will be much advanced. The American Association of Variable Star Observers has attempted to maintain its share of the work on variable stars, and the reprint for 1917 from Popular Astronomy, *Harvard Annals* **79**, part 1, together with the recent publication of the British Astronomical Association, attests to the amount of good material being obtained, especially on the long period variables and a few of the more interesting irregular variables.

The formal organization of the American Association of Variable Star Observers in November last, has placed that organization in the fore as a self-sustaining body of enthusiastic and experienced observers, and, in conjunction with the staff of the Harvard Observatory, it has been able to carefully attend to the observation of over 300

variables. By the formation of a special committee appointed to systematize the work, in order that unnecessary duplication may be avoided and that large gaps may not occur in the continuity of the light-curves, this association hopes to have the work on these stars still better in hand. The help of larger telescopes is needed for the fainter stars, especially those at or near minimum. Stations situated more north and south are also needed in order to further shorten the gaps now occurring, due to the proximity to the sun, and in different longitudes to obviate gaps caused by cloudiness, and for the observation of the rapidly varying stars. Variable star observing has assumed a more international character than ever before and the results attained show that our knowledge of variables, at least as far as observational facts are concerned, is steadily increasing.

It is hoped that some action may be taken on the suggestions made in our first report, toward obtaining information as to the location and sizes of the numerous telescopes distributed over the country, and also as to what sort of work is being done with these instruments, not only among the professionals, but the amateurs as well. There must be many telescopes now idle and owned by private individuals, which might be placed in active use, if we only knew where to find them and where the nearest experienced observer was situated who could make good use of them. The aid of the American Association for the Advancement of Science through a grant sufficient to purchase a five-inch telescope should result favorably once we are able to secure the instrument, and offers suggestions for further progress along this line.

The advent of the bright Nova in Aquila on June 8 is the event of chief importance observationally speaking for some time past, and has offered a splendid opportunity of recording the history of this remarkable star. That variable star tyros were "on the job" so to speak is evidenced by the fact that it was found by so many individuals. In this country alone, it was discovered by at least twenty-four persons, four of whom were not experienced in work of this sort, and eight of whom were members of the American Association of Variable Star Observers, while the remaining twelve were professional astronomers.

The advantage of coöperation in such work, as the frequent observing of a nova, is of particular value, and the variable star organizations are apparently ready and trained to the work of observing such stars. Already many hundreds of observations have been obtained and the form of the light-curve at and near maximum is the most complete of any nova hitherto discovered. It is safe to say that never before in the history of astronomy has a nova been as assiduously and scientifically observed as has Nova Aquilae No. 3.

Valuable aid has been rendered variable star observing by the Leander McCormick and Goodsell Observatories by observing variables when too faint for the smaller telescopes.

The amount of material gathered during the past year will doubtless exceed 20,000 observations of the long period and irregular variables alone, and this includes 300 northern and 100 southern variables. It is now possible to predict the dates of maxima and minima for almost all of these variables with a degree of accuracy hitherto unattainable.

On the whole, we may point to the past year as one of gratifying achievement in the observation of variable stars.

REPORT OF THE COMMITTEE ON THE ADVISABILITY OF SUBSTITUTING THE CIVIL DAY, BEGINNING AT MIDNIGHT, FOR THE ASTRONOMICAL DAY, BEGINNING AT NOON.

The committee endeavored to obtain the opinions of those interested, by publishing in the *Astrophysical Journal*, POPULAR ASTRONOMY, and *Science* a request for such opinions; by sending a request to several of the larger observatories for an expression of opinion from the members of the staff of each; and later by requesting several steamship companies to furnish the opinions of their navigators. Replies were received from four observatories and twenty individuals. The opinions expressed were about three to one in favor of the proposed change.

A meeting of the committee was held in Washington on April 24, 1918 and further discussion was carried on by mail.

The committee recommends that, commencing on January 1, 1925, astronomers and astronomical publications adopt for all purposes the day now in use in civil life beginning at midnight and that the practice be followed of numbering the twenty-four hours of the day consecutively from 0^h to 24^h, provided that the directors of the various national almanacs agree to the same.

The committee also recommends that all data given in the national almanacs for equidistant intervals of time and now given sometimes for Greenwich mean noon and sometimes for Greenwich mean midnight be given for Greenwich Midnight, i. e. for 0^h Greenwich Civil Time.

Referring to the circular letter of March 8, 1918 from the Royal Astronomical Society, the committee does not approve the suggestion "that there should be no alteration in the system of reckoning by Julian days, which should begin, as heretofore, at Greenwich noon". To follow this suggestion will require each observer, after 1925, who wishes to publish his results in Julian days, as is done for variable star observations each month in POPULAR ASTRONOMY, after he has recorded the time of his observation from his ordinary time piece and

transformed the time to decimal of a day, to subtract $0^d.5$. It is feared that one can never be certain whether or not the observer has subtracted the half day, and the committee believes that there will be much less liability of error if after 1925 the Julian day is counted from midnight, and that it be left to the astronomer who discusses the observations to add $0^d.5$ to all times before 1925 when using together observations made before and those made after 1925.

The committee recommends that G. C. T. (Greenwich Civil Time) be used to designate mean solar time counted from Greenwich midnight in place of G. M. T. now used to designate mean solar time counted from Greenwich noon, To use G. T. for this purpose, as suggested in the Royal Astronomical Society's letter, is believed to be not sufficiently exclusive of apparent and sidereal times, and might lead to confusion.

The committee does not approve the suggestion "The places of planets would continue to be given for Noon, there being no reason for a change in this respect, which would in fact be inconvenient, since their Heliocentric places for noon have already been published up to the year 1940". The committee strongly recommends that the geocentric positions of the sun and planets should be given in the annual almanacs for Greenwich mean midnight and not for mean noon, and that the heliocentric positions when published in the future, should also be for Greenwich mean midnight. If a mariner or an astronomer wants the position of the sun or of a planet at a certain instant, he will convert the local time into Greenwich time and will have, according to the new scheme, the number of hours or decimal of a day from Greenwich midnight. The almanac should be constructed so that this number is his interpolating factor. If the positions are given for noon the computer will have to subtract 12^h or $0^d.5$ to obtain the interpolating factor for use with the ephemeris data, the exact counterpart of the thing we are trying to avoid by changing the beginning of the day to midnight.

Also the almanacs should give the sidereal time for midnight instead of for noon, as at present. Then

$$\text{Sidereal time} = \text{Civil time (expressed in sidereal hours)} + \text{Sidereal time of midnight (corrected for longitude)}.$$

Otherwise, if the almanacs should give the sidereal time for noon,

$$\text{Sidereal time} = (\text{Civil time} - 12^h)\ (\text{expressed in sidereal hours}) + \text{Sidereal time of noon (corrected for longitude.)}$$

In order that Chapter II, on Time, of Chauvenet's *Spherical and Practical Astronomy*, may conform to the new day it will be sufficient to make the following changes.

A *solar day* is the interval of time between two successive *lower* transits of the sun over the same meridian.

The *solar time* at any instant is the hour angle of the sun at that instant, west of the meridian, increased or decreased by 12^h according as the hour angle is less or greater than 12^h.

The *mean solar day* extending from midnight to midnight and divided by astronomers into 24 hours reckoned from 0^h to 24^h, is divided in civil life into two periods of twelve hours each, namely, from midnight to noon, marked A. M., and from noon to midnight, marked P. M., the hours of each period being reckoned from 0^h to 12^h. In all astronomical problems, the civil reckoning must be changed to the astronomical before beginning the solution of the problem.

And, in general, wherever the hour angle or the right ascension of the mean sun is used in a time definition or equation, each must be increased or decreased by 12 hours.

The committee feels strongly that any changes in fundamental time systems, or in any important conventions of the various nautical almanacs, which can now be foreseen as desirable in the next half-century, should all go into effect at one and the same time, preferably January 1, 1925. This principle has governed the committee's recommendations.

W. S. Eichelberger, Chairman,
W. W. Campbell,
Edwin B. Frost.

REPORT OF THE COMMITTEE ON STELLAR PARALLAXES FOR THE YEAR ENDING JUNE 30, 1918.

As in previous years, the coöperative observers have kept each other informed as to additions to the observing lists, stars abandoned, etc. There has been much helpful correspondence concerning methods, arrangement of the observing programs, choice of stars to be observed and the like. As is seen from the reports of the individual observatories which follow, the war has greatly interfered with the progress of the work.

Allegheny Observatory. During the year 2958 successful parallax plates were secured and 1865 were measured. The parallaxes of fifty stars have been published in the publications of the observatory. Observations have been begun on 327 new regions and the observations

have been completed for 122 regions. A list of about 600 stars has been prepared, including all stars brighter than 5.5 magnitude north of declination $-13°$, except stars of the spectral type B. The stars of this list will gradually be taken into the program to replace those for which the observations are completed. A thin absorbing cover glass has been used in addition to the rotating sector in order to reduce the light of some of the brightest stars. During most of the year, the director has been absent from the observatory on war work.

(FRANK SCHLESINGER).

Dearborn Observatory. Up to June 30, 1918, thirty nine parallaxes have been completed. One of these, Barnard's star of large proper motion, has been published in *Astronomical Journal*, No. 734. On account of the director's continued absence on war work, no plates have been taken since September 23, 1917. (PHILIP FOX).

Greenwich Observatory. On account of the war, no parallax work has been done during the year. (F. W. DYSON).

McCormick Observatory. The director was absent from the observatory for part of the year while on war work and while observing the total eclipse of the sun. On July 1, 1918, the observatory staff was reduced to one observer and one computer. In spite of these drawbacks, the parallax work has been carried on as well as the reduced staff would permit. During the year, 1343 plates were taken. Two hundred parallaxes have now been completed and the results are ready for the printer, the publication, unfortunately, having been delayed. 108 stars were added to the observing list.

(S. A. MITCHELL).

Mount Wilson Observatory. Since the last report 301 plates with 447 exposures have been secured. Eighty fields have now been finished; the results are published in *Mt. Wilson Contributions* 111, 136 and 158. The observing program had seventeen stars and six clusters added to it while twelve clusters were abandoned.

SPECTROSCOPIC DETERMINATIONS OF PARALLAX.

A list of the absolute magnitudes and parallaxes of 500 stars was published by Adams and Joy in the *Astrophysical Journal* for December 1917. Of these stars 360 have parallaxes measured in the usual way by various observers and a full comparison with their results is given in this publication.

About 600 additional determinations of absolute magnitude and parallax are now available from results based upon one or more spectrograms. These stars belong for the most part to three classes:

1. Stars of the *American Ephemeris* list with spectral types betweeen A8 and M.
2. Stars of proper motion exceeding $0''.50$ annually, most of them being of the eighth magnitude or fainter.
3. A considerable number of F, G and K type stars selected from Boss's Catalogue on the basis of small or moderate proper motion.

The working list at present includes additional stars of these classes, and all stars of the more advanced spectral types for which trigonometrical parallaxes have been published. A nearly complete list of Cepheid variables is also included. (W. S. ADAMS).

Sproul Observatory (Swarthmore College). During the past year we have obtained 634 parallax plates. Fourteen new fields have been added to the observing program, and three fields have been rejected. The parallax results for 23 additional stars have been obtained.

(JOHN A. MILLER).

Van Vleck Observatory (Middletown). Owing to the continued absence of the director on war work, nothing has been done on stellar parallax. (FREDERICK SLOCUM).

Yerkes Observatory. The work has been in charge of Mr. Van Biesbroeck. Mr. Lee has been absent from the observatory as instructor in navigation in the school of the U. S. Shipping Board at Chicago. Miss Steele assisted regularly in the work until December 31; Mr. Edison Pettit, from January 1 to May 15, when he left to observe the eclipse; Miss Alice H. Farnsworth helped in the observing during the latter part of May and early June.

552 plates were taken, most of them with two, and some with three exposures. The share of the different observers in the guiding was about as follows:

Van Biesbroeck	45 per cent
Sullivan	25 " "
Pettit	17 " "
Miss Steele	11 " "

Weather conditions were unusually bad in October, but were otherwise above the average. During the winter there was some difficulty in getting Cramer Iso plates of the requisite speed. A particularly fast emulsion was secured in the spring.

Early in 1917 a possible source of error was detected by Mr. Lee in the arrangement of the rotating sector. As this does not travel with the plateholder, it can occur that the cone of the light from the parallax star gets too near to the edge of the sector, especially on the longer exposures. This danger was increased, when the plateholder was

moved to use the spot-plate method of Kapteyn, inasmuch as the sector was thereby farther removed from the plate. Abnormal deviations were found in the measures of some plates due to the fact that only part of the cone of light of the parallax star had been occulted. The different fields have now been carefully checked at the telescope and the required settings recorded for the future. A change of the apparatus will soon be made so that the sector will be rigidly attached to the moving plateholder. New series of plates were begun for some fields which were possibly subject to this error. Mr. Van Biesbroeck gave much time to the revision of all the plates of unfinished fields. A selection of comparison stars was made and the apparent brightness of the parallax star reduced to the required amount. Any previous plates had to be discarded which had been taken under different conditions for the different guiding stars and different apertures of the sector, so that material was not homogeneous. All the series are now kept strictly uniform and the proportion of plates to be rejected has been reduced to a very small percentage.

A number of parallaxes have been computed, but none have been published during the year. No computer was available for the department of parallax during the year.

13 stars were added to the observing program, and 7 stars were abandoned. (EDWIN B. FROST).

NOVA AQUILAE 3rd.

J. A. PARKHURST.

To test the presence of nebulosity around the Nova an exposure was made with the 2-foot reflector of the Yerkes Observatory on the morning of February 8, 1919. On account of the morning twilight only 40 minutes exposure was possible, but no certain trace of nebulosity was visible around the photographic image.

Spectrum plates have been taken at frequent intervals to follow any changes which might occur, especially near the conjunction with the sun. Besides those taken with the patrol camera, which will be described elsewhere, 21 plates have been taken, with prisms of 15° and 30° angle and 14.5 cm clear aperture, since November 1, 1918. Only short exposures were possible in December and January, and for these the 15° prism was used on the Zeiss UV camera. Three plates were secured in December, on the 14th and 19th; and eight plates in January, beginning on the 15th. The interval with no plates near conjunction

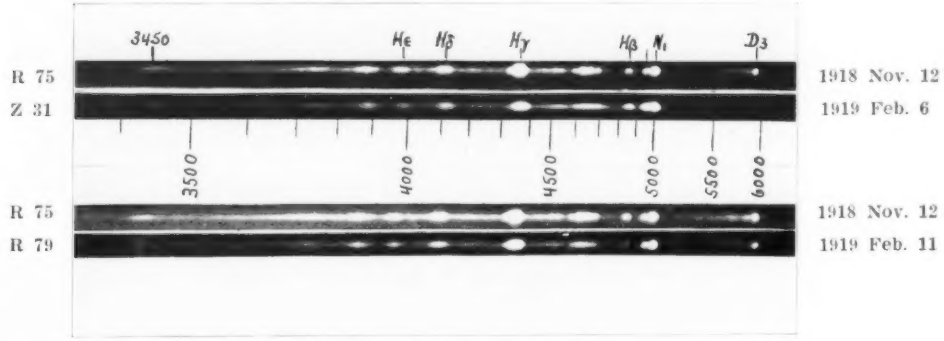
with the sun was therefore 27 days. Only slight changes were found between the spectra of December and January, but these plates are difficult to reproduce on account of their small scale. The cut (Plate X) therefore gives a comparison of negative R 75, taken 1918 November 12 with the 15° prism on the Brashear reflector of 15 cm aperture, using a Cramer Isochromatic Instantaneous plate; first with Z 31, taken 1919 February 6, with the 30° prism on the Zeiss Camera of 14.5 cm aperture, using a Seed 30 plate, and second with R 79 taken 1919 February 11 with the same equipment as R 75.

The most conspicuous bright lines in the spectrum of November 12, beginning at the right (towards the red), are the Helium line D_3 in the yellow, the nebular lines N_1 and N_2 in the greenish blue, and the Hydrogen series $H\beta$, $H\gamma$, $H\delta$, $H\epsilon$, $H\zeta$ and so forth, and a bright region in the extreme ultra-violet about wave-length 3450 A. These are connected by a faint continuous spectrum with some well-marked absorption lines. Compared with this the spectrum of February 6 shows some changes. It was taken on a Seed 30 plate which is insensitive to yellow light, therefore the D_3 line does not appear. The nebular lines and $H\beta$ seem stronger in relation to $H\gamma$. To the left (violet) of $H\gamma$ the spectrum is not in good focus, since it was taken through an objective instead of by means of a mirror, as was R 75 of November 12. As a fact this defect in focus affects also the lines N_1, N_2, and $H\beta$, making them appear too strong. For this reason R 75 of November 12 is also compared with R 79 of February 11, the latter plate being weaker than the former, since the Nova was then fainter and only a short exposure was possible on account of the twilight. Except for the difference in strength, these plates should be strictly comparable, since they were taken with the same equipment; but unless allowance is made for this difference, the comparison will be misleading. The bright $H\beta$ and the continuous spectrum between D_3 and N_1 are near the limit of visibility on the plate and they therefore appear too faint. We will come nearest to the truth therefore by making a compromise between the two pairs of spectra, which leads us to the conclusion that the principal changes between November and February lie in the weakening of the $H\beta$ line and a slight strengthening of the nebular lines N_1 and N_2.

Visual observations show a third change, since the red $H\alpha$ line of hydrogen was visible with the 15° prism on the reflector in November, but cannot be seen with the same instrument in February. This is in line with the ordinary development of this class of objects; that is, the appearance and disappearance of the bright lines begin at the red end of the spectrum.

Yerkes Observatory,
1919 February 15.

PLATE X



SPECTROGRAMS OF NOVA AQUILAE 3.

SATURN. THE WONDER OF THE WORLDS.

JOHN H. THAYER.

I want to tell you of a beautiful light in the winter skies which I delight to call my own.

Many have asked me at various times, "Where did you learn to love the light of Saturn?" I remember well the wonderful nights when first the beauty and pleasure of the golden lights of the heavens were mine,—there on the pink laurel-crowned hill-sides of old York State, in June, beside the still running Delaware River, where quiet, peace and stillness reign,—there came into my soul and into my life, the love of one quiet serene light, reposing seemingly so peaceful, amidst the star-shot darkness of the night time skies.

Wonderful, calm, serene, mysterious, slow-going, but altogether beautiful, with its dull yellow light, Saturn, glowing amid the myriad twinkling and glittering hosts of stars, differing from them to such an extent, that instinctively you quickly understand that here is that one thing that will at once bring out of man all the wonder, all the love, all the homage, and all the reverence and joy in the wonderful creations, not of man, but of his maker, God.

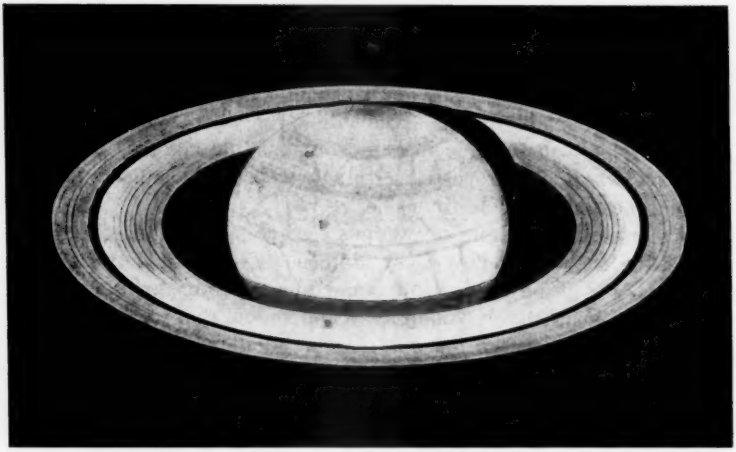
To the unaided eye, Saturn appears as a star of the first magnitude, with none of the bright yellow brilliancy of Jupiter, the soft white luminosity of Venus, or the fiery red light of Mars, consequently to the ancients Saturn was the least interesting of all the planets, and today without the great telescopes to tell us what it is, we would be of the same opinion.

But turn on it a telescope, and what a difference of opinion we must immediately form; for, from being the least of all it becomes the greatest, the grandest, the most amazing of all the sights of the heavens, and, as far as is known, within the stellar universe itself.

Through a telescope this glorious orb appears, its disc banded and mottled somewhat like Jupiter, only fainter perhaps on account of its greater distance from us, and surrounding that globe, a series of three stately rings appear;—two bright and one dark or dusky, called the "Crape Ring." They are symmetrical in shape, perfect in design and color, and in all exquisitely beautiful. And yet again, farther out, circle ten superb moons, the largest number any one planet has attending it; some so small they can be seen only on a photographic plate, yet all are known to belong to this gorgeous system.

It is impossible to repress an exclamation of admiration, surprise and wonder, when first this magnificent system is seen through a telescope tube.

There, in some mysterious way it seems, that giant ball of gold is suspended within the curving, circling rings of golden fire, and Professor Young has said, "This sight is unlike anything else in all the universe, it is the most beautiful and the most interesting of all of our telescopic objects."



SATURN, FROM A DRAWING BY LOWELL.

Our sense of the remarkable things God has created is deepened and broadened, and we can but wonder, if there are beings on that globe such as we, what must be their conception of this earth, seen by them but once in many years, and then only as a little black spot on the face of the sun, when the earth passes directly between the two.

The globe of Saturn is second in size of all the planets, Jupiter being the largest; the equatorial diameter of Saturn measures 76,470 miles, the polar diameter 69,780 miles. Here you will note a difference of 6690 miles; the diameter of the earth is 7918 miles, just a little more than the difference between the equatorial and polar diameters of Saturn. This will in a way give you an idea of the enormous size of Saturn when compared with the earth.

The great difference in the diameters of the two planets is exceeded by the surface and volume measurements. Taking the earth's surface and volume as units respectively, the surface of Saturn is eighty-five times greater, and the volume is seven hundred and eighty-three times

larger than that of the earth, but its surface gravity is about the same, being only .18 greater, and the mass of the ringed planet is a little less than ninety-five times that of our earth.

The density of the planet Saturn is .72 that of water, and if an ocean could be found large enough, and Saturn dropped into it, it would float. Its density is therefore about that of walnut wood, and must be largely of a vaporish condition, probably the greater portion of its constitution being purely gaseous, and being opaque, the gases must be filled with minute particles, about as our air is, when in the process of forming clouds it is charged with small globules of water.

Saturn is a world in the making, in the earlier stages of development, much lighter than Jupiter. Being less dense than water, this globe must be a seething rolling mass of vapors. At its center there is probably an intensely hot solid or semi-solid nucleus, but the greater portion of this great globe, 76,000 miles in diameter, is composed of cooling and condensing vapors and gases kept in rapid circulation by the intense heat of a great central core.

Fifty years ago, Proctor wrote these words: "It seems impossible to doubt that Saturn is inhabited by living creatures of some sort." Today we know that Saturn cannot be the abode of life in any form, for the temperature is so high that metals and rocks melt, and the surface we see through our telescopes is but the outer portion of a constantly shifting mass of vapors and clouds.

It requires twenty-nine and one-half earth years to complete one circuit of the heavens, which is one Saturn year, and owing to the immense size of its orbit, nine and one-half times that of the earth's or, five and one-half billion miles, and its speed of only six miles per second in the orbit, its motion among the stars is extremely slow; from which motion it no doubt derives its name, the Latin "Saturn."

The length of a Saturn day, or its period of one rotation on its axis, is ten and one-quarter earth hours. Whirling at this awful speed, and taking into account its enormous size, the sun when viewed from its surface appears to skim across the sky very quickly, and will appear from Saturn to be about three times as bright as Venus does to us. In every minute of time the sun will move about the distance of the diameter of our moon.

These little ten and one-quarter hour days, with first the sun and then the stars shooting across the sky, present a lively aspect, and if all remain the same, what a splendid panorama it will be for the people of that planet, when it will have sufficiently cooled and solidified to maintain life as we understand it.

Saturn is almost twice as far from the sun as is Jupiter, its mean distance from the sun is eight hundred and eighty-seven million

(887,000,000) miles. This distance varies one hundred million miles on account of the eccentricity of its orbit; its nearest approach to the earth can be seven hundred and fifty-four million miles, and its farthest distance one billion and thirty million miles. At this distance light, traveling one hundred and eighty-six thousand three hundred and thirty miles per second, requires one and one-half hours to pass from Saturn to the earth, and at its nearest position, one hour and six minutes.

Saturn, because of its unique beauty, its wonderful light, and its steadfastness of color, had for many years been studied not only by the wise men of Greece, Egypt and China, but by the simple-minded shepherds of the Galilean and Judean hills, and we can understand how it was, that this bright shining point of light should be one of the first on which Galileo would train his wonderful optic tube, when he perfected it in the year 1610.

In July of that year he first saw Saturn with his telescope, which magnified about thirty times, and undoubtedly was far inferior to our pocket telescopes of today, but he utterly failed then or ever afterwards to recognize the true character of what he saw.

However, what did appear in his glass at once convinced him that something was vastly different with Saturn, for what he saw was not the true slightly oval shaped disc such as all the other planets showed, and Galileo to his friend Kepler wrote these words: "Saturn consists of three stars in contact with each other." He also said, "I have observed the farthest planet to be triple.

Any one looking at the planet with a very small telescope will readily understand why he expressed himself in this manner, for this luminous ball, surrounded by a series of flat rings of light, at certain times will appear as if having two small appendages, attached one on each side.

Further observations perplexed him more and more, for within a year and a half the rings disappeared and Saturn showed a clear round but slightly oval shaped disc.

The plane in which the rings revolve about the planet is the plane of Saturn's equator, and the axis of this system is inclined twenty-seven degrees; the result of this is that at the time of Saturn's equinoxes the edge of the ring system is turned toward us, and on account of their thinness disappear in all but our most powerful telescopes. Half way between the equinoxes they open out wide again to our view, and these views alternate every fifteen years. In 1915 the rings appeared opened out to their widest extent, and from then on till 1921 they will gradually diminish in width, and then apparently disappear as they did in 1907.

This singular behavior of the rings, becoming invisible to Galileo as they did, completely baffled him, and it is said he asked in consternation, "Has Saturn devoured his children?" and we read of him, that "His amazement at that time was pitiful, and his enemies laughed at him in his disappointment, and in what they regarded as deception by him."

However in 1616, as the rings opened out again, he caught sight of them and thought they were handles, for as such they appeared to him. Becoming blind in his later years he never recognized their true form, always supposing them to be subsidiary bodies attending Saturn.

This ring puzzle remained unanswered for forty years, and many curious drawings were made of Saturn and his children, and many and varied were the explanations made of this startling phenomenon.

It remained for the noted Dutch astronomer, Christopher Huygens, to solve the puzzle. He had enlarged and improved upon the telescopes of the day and, finally making one of 123 feet focal length, began to examine Saturn.

In 1656, he first announced that what was seen in his telescope was a ring, and this is the way he did it: In those far off days it was necessary for scientific men, when announcing their discoveries to the world, to resort to anagrams to protect themselves and guard against being robbed of the fruit of their mind's work while they sought proof of it. In our day this purpose is served in a fashion by laws regulating copy and patent rights.

Accordingly Huygens intimated to the world his new discovery by publishing the following singular anagram:

" aaaaaaa cccc d eeeee g h iiiiiii llll
mm nnnnnnnnn oooo pp rr s tttt uuuuu."

Three years later having satisfied himself that his theory was correct, he arranged and published a latin statement from the letters, which when translated into the English language becomes:

"The planet is surrounded by a slender flat ring, inclined to the ecliptic, and nowhere touches the body of the planet,"

This discovery was not a piece of guesswork, for he had spent several years observing carefully the changes of the rings, and finally coming to the conclusion that only the existence of a flat ring in form would explain the curious and mysterious changes, he predicted that in July or August, 1671, the planet would again appear round and the rings would disappear. The prediction proved practically correct, for in May, 1671, Cassini, at Paris, saw the planet as a round disc, unaccompanied by ring or appendage of any shape. Thus was solved the difficult puzzle which had been too much for the master mind of Galileo.

A few years later Cassini discovered a black stripe running completely around the ring, and announced that the ring was really composed of two concentric rings, the inner one being the broader and brighter. This dark space or stripe separating the two rings is now known as Cassini's division.

Many other divisions have been suggested, but only one other is recognized, the so-called Encke division, which separates the outer ring into two nearly equal divisions.

In 1850 C. P. Bond, at Harvard, discovered what is now called the "Crape ring," very faint when compared with the other two, so faint that it actually appears dusky and fades away until it is indistinct at its inner edge. This crape ring is rather a gray border to its more brilliant neighbor, and some astronomers have stated that at times they have noted a fine black line separating the two.

The thickness of this ring system seen edgewise has been variously estimated. Herschel's figure stands at 250 miles, which is the outside limit ever placed on it, and Bond's estimate has reduced this to 40 miles, and it is generally conceded that 100 miles is not far from the actual thickness.

Professor Charles A. Young has stated that, "If a model of this system be constructed to scale and one inch represent 10,000 miles, the diameter of the outside edge of the outside ring will be seventeen inches, and the thickness of the rings seen edgewise, will be represented by the thickness of an ordinary sheet of writing paper."

The latest and accepted measurements of the dimensions of the Saturnian system are these:

Diameter of the planet.....	76,470 miles,
Between planet and Crape Ring.....	5,865 miles,
Diameter inner edge, Crape Ring..	88,200 miles,
Width of the Crape Ring.....	10,900 miles,
Diameter inner edge, Inner Ring.....	110,000 miles,
Width of the Inner Ring.....	18,000 miles,
Width of Cassini's Division.....	2,240 miles,
Width of the Outer Ring.....	11,060 miles,
Diameter outside edge, Outside Ring....	172,600 miles.

This enormous planet with its wonderful, imposing system of rings, fills the mind with feelings of awe and wonder, and our sense of the marvelous creations of God are broadened and deepened, when it is borne in mind that here is a giant planet, seven hundred and eighty-three times larger than the earth, surrounded by a celestial deck on which four balls each the size of the earth can roll abreast around and around that planet.

What is the nature of these marvelous rings? Are they gaseous or are they a solid substance? They are, we have said, broad and flat and

touch the planet at no point and, whether more than three or not in number, they cannot be solid, for the constant gravitational attraction of the central globe would at once dislocate and break them up.

It might be easier to admit that they are liquid, but in this case there would be a transformation of motion into heat, heat into vaporish gas, and then a positive fall onto the planet. The gravitational force of the great globe would at once destroy that beautiful arch if it were either liquid or solid, as was thought for so many years.

In 1857, Clerk Maxwell proved they could be neither, and his conclusions demonstrated that the rings were great swarms of minute particles of matter, each particle traveling about the planet in its own independent orbit. The continuity therefore of this strange beautiful structure is one of appearance only, not of substance.

Then in 1895 James E. Keeler brought out his direct observational proof that this theory is correct, for by the means of that wonderful instrument, the spectroscope, with which we have found that light results from the vibrations of that all pervading insensible something we call ether, he was able to measure the speed of rotation of various parts of the rings.

He found the inner edge of the rings moving with greater rapidity, and this speed diminishing until the outer edge was reached, and that each and every particle composing the rings moved at a speed that a satellite would have were it situated at the same distance from the planet.

Keeler, applying the spectroscope to the light of Saturn, found by examining the lightwaves that one side was approaching us and the other receding. This was in accord with the known fact that Saturn rotates on its axis, and in regard to the rings, the fact was satisfactorily and entirely established that the inner edge rotated faster than the outer, and for the first time astronomy came into possession of observational proof of the nature of Saturn's rings, and Galileo's puzzle was forever solved.

If you want to see a picture painted as only the hand of God can paint it, go with me to Saturn, alight at the north pole and start on a trip to its equator.

On arriving at the 63° of latitude there will be seen rising out of the southern heavens, a ribbon of silver light, which as we go on southward, will rise higher and higher in the heavens, and at the same time apparently diminish in breadth, and at last when we stand on the equator, this wonderful band of light, starting at the eastern horizon will ascend the eastern sky, pass over our heads at the zenith, and descend into the west. Directly overhead the arch will not be seen, for it is evening, and the sun is on the opposite side of the planet. The shadow

cast by the planet is on the arch, but we know it is there, for between the divisions and at each side of the arch, the glorious everlasting stars shine out. It might seem that this picture is now complete, but add to this marvellous sight, this bewildering panorama, as many as ten moons shining in Saturn's sky, some showing the full round disc, some exhibiting the quarter phase we see in our skies, and others the thin crescent shapes we like to look at in the early evenings; and then some conception, some idea, can be gained of the amazing variety of magnificent pictures the Saturnian nights display.

This splendid spectacle is wonderfully beautiful and the mystery of it all will hold you fascinated and breathless with surprise and admiration.

In three ways Saturn is unique within the Solar System; it has its wonderful ring system, it has more moons than any other planet, and it is light enough to float on water.

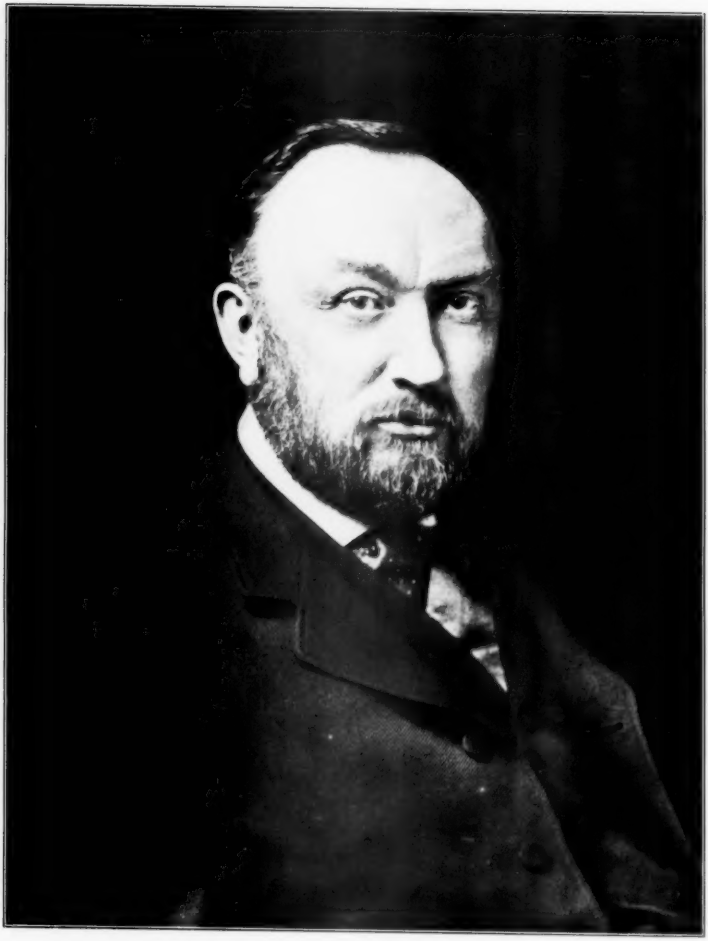
The largest of the moons is Titan, discovered by Huygens, when studying the planet to find out what the rings were. It is three thousand miles in diameter, therefore about equal to Mercury in size, in fact a little world attending Saturn. The smallest is Themis, discovered in 1905, on a photographic plate; it is so small it cannot be seen even with the help of our largest telescopes. The most remarkable moon of this system, is the one most distant from Saturn, Phoebe, 7,996,000 miles from its primary and requiring sixteen months to make one slow revolution around Saturn. The unexpected thing about this moon is that it travels from east to west, exactly opposite to all motions of all the other moons, and with one possible exception of one other body, opposite to all motions of all members of the solar system.

Just imagine if you can, should the earth have a number of moons attending it, and one would revolve around it opposite to the others, how complicated and bewildering our evening skies would be.

Within the last half century all the wonderful accepted facts I have stated pertaining to the planet Saturn have come to the knowledge of man, and with it a new literature has come, and a new interpretation of the sciences has sprung into existence, also a new hope and faith into the hearts of men.

I see the bright golden cup of human knowledge brimming. I see the fires of human thought burning in the hearts of the young, and they must flare out into the wilderness of space. The time is coming when man will no longer be content with this little conquered planet of ours; and I know not how, or by what method, or with what patience, but he will go out into the deeps I have pictured to you.

PLATE XI



EDWARD CHARLES PICKERING
1846-1919

EDWARD CHARLES PICKERING.

ANNIE J. CANNON.

This distinguished leader of American Astronomy was born on Beacon Hill, in Boston, on July 19, 1846, of a Salem family known and honored since Revolutionary days. His mother was Charlotte Hammond, of Boston. Interested in the stars as a boy, when about twelve years old, he constructed his first telescope from an old pair of spectacle glasses. Dissatisfied with the result, however, he searched the shops on the Hill and found a small second hand lens, from which, with the aid of a piece of stovepipe, he made a telescope which showed Jupiter's satellites. He often regretted in later life, that no one told him in those days of a simple method of estimating the brightness of the stars, so that he might have done some useful work. Except for occasional tours, abroad or to the West, almost always of a scientific nature, he spent his whole life in Boston and Cambridge. Graduating from the Lawrence Scientific School of Harvard University at the age of nineteen, he became, in 1867, Thayer Professor of Physics in the Massachusetts Institute of Technology.

With what ardor and enthusiasm this young Professor in his twenties conducted this department, may be easily seen when we read his "Plan of the Physical Laboratory" opened there in October, 1869, the first laboratory of physical research in our country. He stated that this Laboratory would be open not only to students and teachers of physics, but to men of science, wishing to carry on their researches, where they could have water, steam power, and apparatus of all kinds. So early as this, one of the guiding principles of his life was "There are no secrets in Science," and he stated that any institution might adopt their methods, or any person might have their results. This principle he put in practice very soon. In 1869-70 he devised and put into successful operation an apparatus for the electrical transmission of sound. This apparatus was shown to the classes and was described at a meeting in Troy, N. Y., of the American Association for the Advance-of Science. The time was ripe for a "speaking tube", and, when those who were working on its commercial possibilities came to inquire about his experiments, he freely placed at their disposal all the apparatus he had used and allowed them to use the laboratory for their own investigations.

Although Professor Pickering's teaching proved so inspiring that his pupils often remained long after the time, encroaching upon dinner and recreation hours, his far greater interest in investigation was shown even then, for he said, "I have endeavored to impress on all our students in physics the principle that original investigation should be the great aim of every scientific man."

The opportunity for original investigation soon came to him. In 1876, he was appointed by President Eliot to be Director of the Astronomical Observatory of Harvard College. President Eliot recently described the great surprise caused by his peculiar appointment of a physicist to direct an observatory, but he added that his mind had long since been relieved of all care concerning it,—first by the remarkable development of Astronomy along physical lines, and, secondly, by Professor Pickering's great administrative ability.

The new Director entered upon his duties on February 1, 1877, and at once set to work to choose a subject for the use of the large equatorial, then one of the giants of the telescopic world. He chose photometry, which gave promise of being useful and was not likely to be duplicated. Not satisfied with existing photometers, by means of which the star's light was compared with an artificial light quite dissimilar in appearance, he devised one of a different order, in which a star was compared with some bright star in the vicinity. Although threatened with pulmonary trouble at this time and warned that night air might cause him to go into decline, he at once commenced observations with characteristic energy. In later years he often referred to these warnings and laughingly asserted that he was one of the first to discover the fresh air cure for consumption.

He obtained with his photometer the first accurate measures of the brightness of double stars, of the satellites of Jupiter, Uranus, and Neptune, and of Phobos and Deimos, then just discovered. Photometric works appeared in rapid succession in the Harvard Annals. In 1884, came the "Harvard Photometry", giving the magnitude of all the stars visible to the naked eye in Cambridge, then followed the "Photometric Durchmusterung of Stars to the Magnitude 7.5", "Photometric Observations of Variable Stars," and the "Revised Harvard Photometry," superseding all previous volumes for stars of the magnitude 6.5 and brighter. He himself made one million and four hundred thousand photometric settings for these catalogues. He loved this routine work, sitting hour after hour surrounded by a black curtain to shield his eyes from outside light, and patiently bringing the images of two stars to equality. The accuracy and care which characterize these observations can only be realized when we consider that the variability of the Pole Star, discov-

ered thirty years later, amounting to only about one tenth of a magnitude, was confirmed by Professor Pickering's measures made of it as a comparison star, in the years 1879 to 1882.

While this new Director was thus at work setting large numbers of stars in their order of brightness, chemists were busy, mixing together bromides and gelatines, which were destined to change the whole process of astronomical research. It was the eve of the greatest revolution this ancient science had known since the days when Galileo constructed his rude telescope. Photographs of stars had been taken at Harvard as early as 1850, but the process had been abandoned, due to numerous difficulties, especially the slowness of the wet collodion films. In 1882, the improvements in the dry plate were so great that Professor Pickering's attention was called to the subject of celestial photography. With the readiness for new ideas which always characterized him, he at once commenced a series of experiments, perhaps more in earnest than ever before, realizing, as he said in 1883, the part that photography was likely to play in the future of astronomy. First with a photographic lens having an aperture of seven inches, then with one of eight inches, he began to overcome the small difficulties and errors quite ruinous to a stellar photograph. Although jeered at as only a photographer by old-fashioned astronomers, who declared that a new star could not be distinguished from a defect in the film, he went on, opening up this wonderful new world of the sky, with courage, with faith, and with imagination. As early as 1886, he laid before the American Academy a plan for mapping the whole sky in a single year, by having two stations and keeping the telescopes employed all night. In May 1885 he commenced his spectroscopic survey of the sky by placing a thirty degree prism in front of an object glass of 2½ inches in aperture. Very soon he secured a photograph of the spectra of the Pleiades showing forty stars, nearly all of the first type, from which he concluded that the similarity of their spectra confirmed the theory of their common origin.

The years were now crowded with exhilarating work. His ability and enthusiasm brought friends with means to carry out his plans. In 1885, Mrs. Draper founded at Harvard Observatory the Henry Draper Memorial in memory of her husband, who first photographed the lines in the spectrum of a star, and she gave the Director most generous support by money, instruments, and friendly interest. Soon after, came the Boyden Fund of $230,000 for astronomical investigation at a high elevation, making possible the establishment of the permanent station in Arequipa, Peru. Miss Catherine W. Bruce, of New York, soon made a gift of $50,000 for a large glass, with the result that the 24-inch Bruce Telescope was set up in Arequipa for work on the long-neglected south-

ern stars. Professor Pickering was always interested in big undertakings, and now, seemingly, the whole heavens were to be as an open book, and the field of the Henry Draper Memorial, as he said, was almost boundless. Discovery followed discovery, such as bright lines in the spectra of long period variables, forming a means of discovering the objects, the first spectroscopic binaries found by the peculiar doubling of the spectral lines, gaseous nebulae, and new stars.

He has often spoken of his great surprise, in these early days, that there was such a marked similarity in the spectra of so many stars, as he had thought it possible that they might prove to be of as great variety as flowers. Various catalogues of spectra were issued from time to time, culminating in the Henry Draper Catalogue, which gives the class of spectrum of over 200,000 stars, from the North to the South Pole, and will fill nine volumes of the Annals. He lived to see the first two of these volumes printed and bound and set up on his shelf.

In all his photography of the sky, he was more interested in results than in the art of it, and cared far more for a useful than for a beautiful picture of the stars.

Great interest in stars that vary in light naturally resulted from his photometric work, and he early realized that large accessions to our knowledge of these interesting objects would result from photography. His three methods of search—by the spectrum, by superposing a positive and a negative, and by multiple exposures over the entire night,—have resulted in the discovery of 3435 variables, or more than two thirds of the total number known. He never overlooked the importance of visual work on variable stars, and as early as 1882 he started his appeals for such observations. In this case, as in others, he pleaded that the plan should not be local or even national, and that observations should be made according to the same system. If this plea had met with coöperation instead of opposition in the eighties, as it has in the last fifteen years, how much greater would our knowledge now be concerning these stars! But as in other things, he was ahead of the times, and must patiently wait for a younger generation of observers. This coöperation has been realized in recent years, with the Variable Star Section of the British Astronomical Association and with the American Association of Variable Star Observers. The autumnal meetings of the latter society here have been among our most enjoyable Observatory events. Professor Pickering always greeted the members with great cordiality, and graced the occasion by a dinner or a tea in his own delightful home. On the last occasion of these meetings, he was greatly surprised and pleased by the gift from the Association of a gold paper knife, set with symbolic precious stones. It was a source of utmost pleasure to him that amateurs

instead of merely looking through their telescopes, were, by their own efforts helping to increase the sum of human knowledge. When the New Star appeared in Aquila last June, he was able to say that for the first time a watch was kept of a celestial object by a chain of observers extending around the whole world. While still a very young Professor at the Institute of Technology, he wrote, "Science is an ennobling pursuit only when it is wholly unselfish." Perhaps the highest dream of his life was that astronomers all over the earth should unite in combined efforts to study the sky and to unravel its mysteries. To this end, he commenced in 1886 on his plans for the "Extension of Astronomical Research." The first result was a gift from Miss Bruce of six thousand dollars, from which small grants were made to astronomers in England, Germany, Norway, and Russia, as well as in the United States. At the Franklin Bi-Centennial in April, 1906, he presented his ripened ideas before the American Philosophical Society in in a paper called "An International Southern Telescope." A great telescope was to be put up on the best site on the globe, where photographs should be taken to supply the "particular man" of any nation, the results to be for the use of the world and not for an individual. He had great faith in this plan, and always thought that men of wealth might have approved, except for the unfortunate fact that the news of the San Francisco earthquake and fire came just after the paper was presented, and completely obliterated from every one's mind the possibility of an astronomical Utopia.

In the early days of photographic astronomy, Professor Pickering foresaw a great opportunity for woman's work, and gradually, from 1884, the staff of women assistants was instituted, first for simple computing and examination of the photographs, then for posts of greater responsibility, until independent investigations were made by them. He treated them as equals in the astronomical world, and his attitude towards them was as full of courtesy as if he were meeting them at a social gathering. In later years, he has been deeply interested in the young graduates of women's colleges, having the Maria Mitchell and Pickering Fellowship, for the latter of which a fund of twelve thousand dollars was presented to him in November, 1916, on the fortieth anniversary of his appointment as Director.

He has been President of the American Astronomical Society since 1905. In this capacity, his suavity of manner, ease as a presiding officer, and consideration for every member, have done much to make these gatherings delightful and to promote the harmony now existing in the Society. The meetings of 1898, 1910, and 1918 were held at the Harvard Observatory. In 1910, the presence of famous European astronomers gave distinction to the gathering, and both meetings were

notable for the great-hearted hospitality of the Director, his personal interest in each member and visitor, his constant attention to every detail, and the rare charm of his personality.

He received numerous degrees and honors. Six American Universities conferred the degree of LL. D. upon him, and among the various medals which were awarded him may be mentioned the Henry Draper, the Rumford, the Bruce, and the medal of the Royal Astronomical Society of Great Britain on two occasions. Two foreign Universities gave him a Doctor's degree, and he was a Knight of the Order Pour le Merite. Besides being a member of the American scientific societies, he was honored by being made a member or a foreign Associate of the Royal or National Societies of England, Germany, Ireland, Italy, Mexico, Russia, and Sweden.

Although work was the joy of his life, he was fond of mountain climbing and bicycling in earlier days, and more recently was an interested spectator of the football games and of the historical moving pictures. He was founder and first President of the Appalachian Mountain Club. He was also a lover of music, being able to talk as intelligently of a Beethoven Symphony as of photometric magnitudes.

During the last two years his mind was constantly busy trying to devise useful appliances to help win the war, and he was frequently sending such ideas to the authorities at Washington. It gave him pleasure to know that the device for finding the range of the guns, now called the Pickering Polaris Attachment, was accepted by the Department of War, and that instruments were being made for actual use according to his model.

He made four trips to Europe, beginning with the Solar Eclipse Expedition to Spain in 1870, and ending with the Solar Conference in Bonn in 1913. An interesting paper might be written of the reminiscences and scientific results of these journeys. By means of these visits and of his hospitality towards foreign astronomers visiting this country, his acquaintance was very large on the other side of the Atlantic.

He was married in 1874 to Lizzie Wadsworth, daughter of Jared Sparks, the historian and former President of Harvard College. Mrs. Pickering, who died in 1906, is remembered as a delightful hostess.

One of his greatest pleasures in later days was the harmonious coöperation with other astronomers both at home and abroad. The joint work with Professor Kapteyn on his "Selected Areas" is already printed in Harvard Annals, Volume 101. Another source of satisfaction was that astronomers wished the results of our work. No letter gave him more genuine pleasure than one asking for a long list of spectra, yet unpublished, or other facts from the great storehouse collected here in this Astrophotographic Library of glass plates.

He will be missed for his warm-heartedness, always eager to help the young astronomer, whether by securing grants of funds or in the selection of his life work; for his cordiality, the ideal host in welcoming visitors to the Observatory; for his sympathetic, inspiring personality, which, by its very optimism and faith in humanity, made us believe in ourselves and our capabilities.

His joy in taking part in what he called the greatest problem ever presented to the mind of man, the study of the starry universe, never left him, and, even in his last illness, he spoke of having new ideas about work, and so, on February 3, 1919, in the seventy-third year of his age, he passed on. He measured the light of the stars and first placed them in an orderly evolutionary sequence. He left, as his legacy to the world, the history of the sky for the last thirty-five years imprinted on the Harvard collection of photographs.

Cambridge, Mass.
February, 19, 1919.

PLANET NOTES FOR APRIL, 1919.

The *sun* will move in declination from +4° 14′ to +14° 32′ during this month. Its course will carry it from the constellation Pisces into Aries.

The phases of the *moon* for this month are as follows.

First Quarter	Apr.	7	at 7	A.M.	C.S.T.
Full Moon		15	" 2	"	"
Last Quarter		23	" 5	"	"
New Moon		29	" 11	P.M.	"

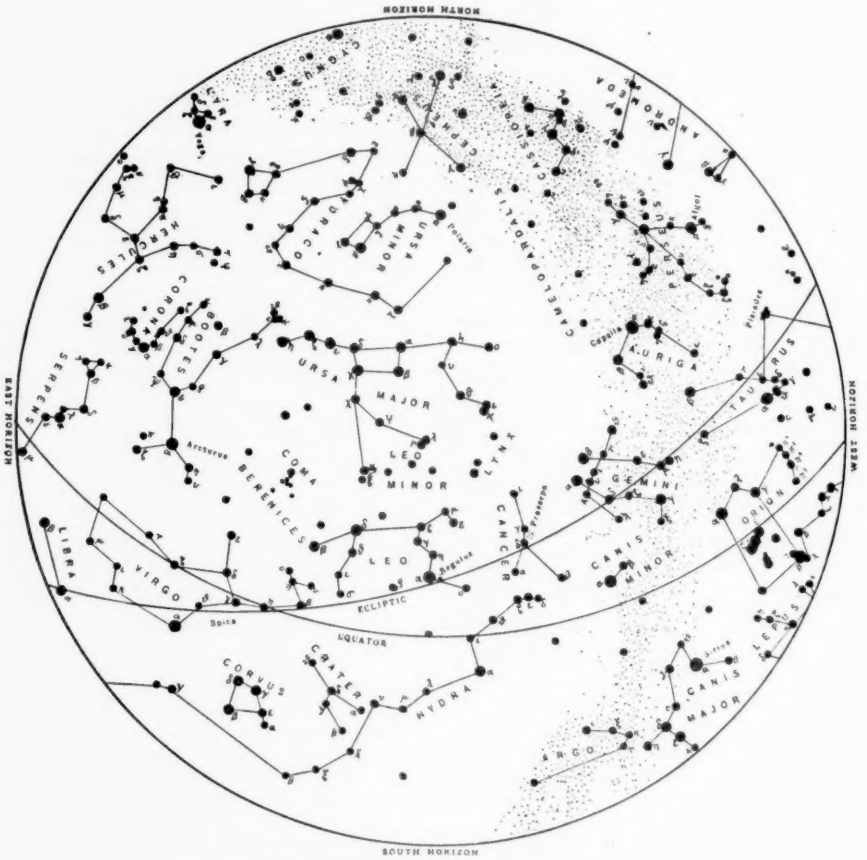
Mercury will scarcely be visible at all during this month. On April 7 it will pass between the earth and the sun from east to west. Toward the end of the month it will be approaching a position of greatest elongation west. It will, however, be about ten degrees south of the sun, which will be unfavarable for its observation in the morning sky.

Venus will continue to be a brilliant object in the western sky during this month. It will be moving eastward more rapidly than the sun. At the end of the month it will cross the meridian about 2:30 in the afternoon. Its brilliancy will be increasing rapidly, as it will be approaching the earth during this month.

Mars will be only a short distance east of the sun. By the end of the month the sun will have moved to within about two degrees of the planet. Mars, therefore, cannot be observed during this month.

Jupiter will still be a conspicuous object in the western sky in the early evening. At the beginning of the month it will cross the meridian at about six o'clock in the evening and at the end of the month at about four o'clock in the evening. The planet will be receding from the earth.

Saturn will be a few hours east of Jupiter and will therefore be even more favorably situated than Jupiter. At the middle of the month it will cross the meridian at about eight o'clock in the evening. Saturn will be in the constellation Leo, near the bright star Regulus.



THE CONSTELLATIONS AT 9:00 P. M. APRIL 1.

Uranus will be visible in the early morning in the southeast.

Neptune will be between Jupiter and Saturn in the sky. It will cross the meridian about 6:30 in the evening and may therefore be observed throughout the month.

Occultations Visible at Washington.

[From the *American Ephemeris.*]

Date 1919	Star's Name	Magnitude	IMMERSION. Washington M.T. h m	IMMERSION. Angle from N. °	EMERSION. Washington M.T. h m	EMERSION. Angle from N. °	Duration h m
Apr. 8	A^1 Cancri	5.5	12 14	105	13 14	300	1 59
9	ω Leonis	5.5	9 23	127	10 44	294	1 21
11	p^3 Leonis	6.1	10 01	104	11 22	321	1 21
21	226 B Sagittarii	6.4	14 10	70	15 31	270	1 21

Phenomena of Jupiter's Satellites.

VISIBLE AT WASHINGTON.

[From the *American Ephemeris.*]

CENTRAL STANDARD TIME.

1919	h	m		
Apr. 2	6	05	II	Ec. R.
	8	40	III	Oc. R.
	10	37	III	Ec. D.
6	8	57	I	Oc. D.
7	6	11	I	Tr. I.
	7	26	I	Sh. I.
	8	25	I	Tr. E.
	8	59	II	Tr. I.
	9	41	I	Sh. E.
8	7	01	I	Ec. R.
9	8	41	II	Ec. R.
	9	30	III	Oc. D.
13	8	06	III	Sh. E.
	10	55	I	Oc. D.
14	8	08	I	Tr. I.
	9	21	I	Sh. I.
	10	22	I	Tr. E.
15	8	57	I	Ec. R.

1919	h	m		
Apr. 18	6	17	II	Sh. E.
20	7	07	III	Tr. E.
	8	45	III	Sh. I.
21	10	05	I	Tr. I.
22	7	22	I	Oc. D.
23	6	49	I	Tr. E.
	8	00	I	Sh. E.
	8	45	II	Oc. D.
24	9	24	IV	Ec. D.
25	6	30	II	Tr. E.
	8	55	II	Sh. E.
27	8	05	III	Tr. I.
29	9	21	I	Oc. D.
30	6	33	I	Tr. I.
	7	40	I	Sh. I.
	8	47	I	Tr. E.
	9	55	I	Sh. E.

Note:—I., denotes ingress; E., egress; D., disappearance; R., reappearance; Ec., eclipse; Oc., occultation; Tr., transit of the satellite; Sh., transit of the shadow.

Saturn's Satellites.

[From the *American Ephemeris.*]

CENTRAL STANDARD TIME.

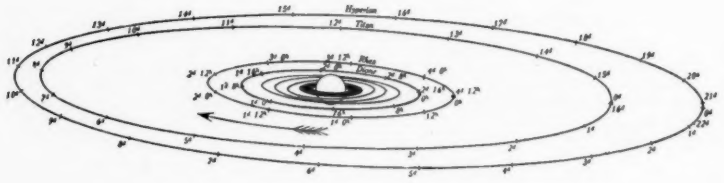
I. Mimas. Period 0^d $22^h.6$.

1919	h		1919	h		1919	h		1919	h	
Apr. 1	12.2	E	Apr. 8	13.8	W	Apr. 16	14.1	E	Apr. 24	14.4	W
2	10.8	E	9	12.4	W	17	12.7	E	25	13.0	W
3	9.4	E	10	11.1	W	18	11.3	E	26	11.6	W
4	8.0	E	11	9.7	W	19	9.9	E	27	10.2	W
5	6.7	E	12	8.3	W	20	8.6	E	28	8.8	W
6	16.6	W	13	6.9	W	21	7.2	E	29	17.5	W
7	15.2	W	15	15.5	E	23	15.7	W			

II. Enceladus. Period $1^d\ 8^h.9$.

	h		h		h		h
Apr. 1	13.6 E	Apr. 9	18.9 E	Apr. 18	0.2 E	Apr. 26	5.6 E
2	22.5 E	11	3.8 E	19	9.1 E	27	14.4 E
4	7.4 E	12	12.7 E	20	18.0 E	28	23.3 E
5	16.3 E	13	21.6 E	22	2.9 E	30	8.2 E
7	1.1 E	15	6.4 E	23	11.8 E		
8	10.0 E	16	15.3 E	24	20.7 E		

South



North

SATELLITES OF SATURN, 1919

Apparent Orbits of the Seven Inner Satellites of Saturn at Date of Opposition, February 14, 1919, as seen in an inverting telescope.

III. Tethys. Period $1^d\ 21^h.3$.

Apr. 2	5.8 E	Apr. 9	19.0 E	Apr. 17	8.3 E	Apr. 24	21.5 E
4	3.1 E	11	16.3 E	19	5.6 E	26	18.8 E
6	0.4 E	13	13.7 E	21	2.9 E	28	16.1 E
7	21.7 E	15	11.0 E	23	0.2 E	30	13.4 E

IV. Dione. Period $2^d\ 17^h.7$.

Apr. 2	6.4 E	Apr. 10	11.4 E	Apr. 18	16.4 E	Apr. 26	21.5 E
5	0.0 E	13	5.1 E	21	10.1 E	29	15.2 E
7	17.7 E	15	22.8 E	24	3.8 E		

V. Rhea. Period $4^d\ 12^h.5$.

Apr. 1	17.0 E	Apr. 10	17.8 E	Apr. 19	14.6 E	Apr. 28	19.5 E
6	5.4 E	15	6.2 E	24	7.0 E		

VI. Titan. Period $15^d\ 23^h.3$.

Apr. 1	5.6 E	Apr. 8	22.8 W	Apr. 17	3.9 E	Apr. 24	21.4 W

VII. Hyperion. Period $21^d\ 7^h.6$.

Apr. 5	16.6 W	Apr. 16	5.9 E	Apr. 26	22.9 W

VIII. Iapetus. Period $79^d\ 22^h.1$.

Apr. 8	9.7 I	Apr. 27	4.7 W

IX. Phoebe. Period $523^d\ 15^h.6$.

	α Ph.—α Sat.	δ Ph.—δ Sat.		α Ph.—α Sat.	δ Ph.—δ Sat.
	m s	′ ″		m s	′ ″
Apr. 1	−2 22.1	+12 41	Apr. 17	−2 24.2	+12 23
3	22.6	40	19	24.2	20
5	23.0	38	21	24.2	16
7	23.3	36	23	24.1	12
9	23.6	34	25	24.0	09
11	23.8	31	27	23.8	06
13	24.0	28	29	−2 23.5	+12 01
15	−2 24.1	+12 26			

VARIABLE STARS.

Minima of Variable Stars of Short Period.

[Calculated by D. C. Kazarinoff at Goodsell Observatory.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5h; Central Standard 6h; etc.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1919 April							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.8	6 6							
RT Sculptor.	31.5	−26 13	9.6—10.5	0 12.3	5 13;	13 6;	20 22;	28 14				
UU Androm.	38.5	+30 24	10.7—11.9	1 11.7	7 22;	15 9;	22 19;	30 6				
U Cephei	0 53.4	+81 20	7.0— 9.0	2 11.8	3 9;	10 20;	18 8;	25 19				
Z Persei	2 33.7	+41 46	9.4—12	3 01.4	6 9;	12 12;	24 17;	30 20				
TW Cassiop.	37.6	+65 19	8.2— 9.0	1 10.3	5 15;	12 18;	19 22;	27 1				
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	4 11;	11 8;	18 5;	25 1				
RZ Cassiop.	39.9	+69 13	6.9— 8.1	1 04.7	6 4;	13 8;	20 12;	27 16				
TX Cassiop.	44.4	+62 22	9.4—10.1	2 22.2	6 6;	15 1;	23 20;	26 18				
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	5 23;	13 22;	21 20;	29 19				
RX Cassiop.	2 58.8	+67 11	8.6— 9.1	32 07.6			18 14					
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	3 6;	14 17;	20 11;	26 4				
RT Persei	16.7	+46 12	9.5—11.5	0 20.4	6 7;	13 2;	19 21;	26 16				
λ Tauri	55.1	+12 12	3.3— 4.2	3 22.9	3 8;	11 6;	19 3;	27 1				
RW Tauri	3 57.8	+27 51	7.1—<11	2 18.5	3 7;	11 15;	19 22;	28 5				
RV Persei	4 04.2	+33 59	9.5—11.0	1 23.4	6 13;	14 11;	22 8;	30 6				
RW Persei	13.3	+42 04	8.8—11.0	13 04.8	1 18;	14 22		28 3				
SZ Tauri	31.4	+18 20	7.2— 7.7	3 03.6	2 23;	12 10;	21 21;	25 0				
RS Cephei	4 48.6	+80 06	9.5—12.0	12 10.1	9 19		22 5					
TT Aurigae	5 02.8	+39 27	7.8— 8.7	0 16.0	8 21;	15 13;	22 5;	28 21				
RY Aurigae	11.5	+38 13	10.7—11.7	2 17.5	1 4;	9 8;	17 13;	25 17				
RZ Aurigae	42.9	+31 40	10.6—13.3	3 00.3	7 13;	13 14;	19 14;	25 15				
SV Tauri	45.8	+28 05	9.4—11.0	2 04.0	6 1;	14 17;	23 9;	27 17				
Z Orionis	50.2	+13 40	9.7—10.7	5 04.9	4 5;	14 15;	19 20;	25 1				
SV Gemin.	54.6	+24 28	9.8—<11	4 00.2	3 9;	11 10;	19 10;	27 10				
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	4 15;	16 2;	21 19;	27 13				
U Columbae	6 11.2	−33 03	9.2—10.0	2 19.2	2 19;	14 0;	25 5;	30 19				
SX Gemin.	22.0	+20 37	10.8—11.5	1 08.8	5 22;	14 2;	22 7;	30 12				
RW Monoc.	29.3	+ 8 54	9.0—10.8	1 21.7	8 0;	15 15;	23 6;	30 21				
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0		10 19;	23 0					
RU Monoc.	6 49.4	− 7 28	9.8—10.5	0 21.5	4 4;	11 8;	18 13;	25 17				
R Can. Maj.	7 14.9	−16 12	5.8— 6.4	1 03.3	6 15;	13 11;	20 6;	27 2				
RY Gemin.	21.7	+15 52	8.9—<10	9 07.2	2 18;	12 1;	21 8;	30 15				
Y Camelop.	27.6	+76 17	9.5—12	3 07.3	2 10;	15 15;	22 6;	28 20				
TX Gemin.	30.3	+17 8	10.0—11.9	2 19.2	8 15;	17 0;	19 20;	25 10				
RR Puppis	43.5	−41 08	9.4—10.7	6 10.3	7 10;	13 21;	20 7;	26 18				
V Puppis	7 55.4	−48 58	4.1— 4.8	1 10.9	4 14;	11 21;	19 3;	26 10				
X Carinae	8 29.1	−58 53	7.9— 8.7	0 13.0	3 20;	11 23;	20 2;	28 5				
S Cancri	8 38.2	+19 24	8.2—10	9 11.6	7 10		16 21;	26 9				
RX Hydrae	9 00.8	− 7 52	9.1—10.5	2 6.8	8 20;	15 16;	22 13;	29 9				
S Velorum	29.4	−44 46	7.8— 9.3	5 22.4	3 11;	15 7;	21 6;	27 4				
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	4 20;	11 14;	18 8;	25 2				
RR Velorum	10 17.8	−41 36	10.0—10.9	1 20.5	7 21;	15 7;	22 17;	30 3				
SS Carinae	10 54.2	−61 23	12.2—12.8	3 07.2	6 22;	13 12;	20 3;	26 17				
ST Urs. Maj.	11 22.4	+45 44	6.7— 7.2	8 19.2	8 0		16 19;	25 14				
RW Urs. Maj.	35.4	−52 34	10.3—11.4	7 07.9	8 22;	16 16;	23 14;	30 22				
Z Draconis	11 39.8	+72 49	9.9—13.6	1 08.6	4 16;	11 11;	18 6;	25 1				
RZ Centauri	12 55.6	−64 05	8.5— 8.9	1 21.0	5 20;	13 8;	20 20;	28 8				
RS Can. Ven.	13 06.3	+36 28	7.5—12.5	4 19.1	4 6;	13 20;	23 11;	28 6				
SS Centauri	13 07.2	−63 37	8.8—10.4	2 11.5	2 20;	10 7;	17 17;	25 4				
133926 Hydrae	13 39.0	−26 23	8.6—12.7	2 21.5	4 3;	15 17;	21 12;	27 7				
δ Librae	14 55.6	− 8 07	4.8— 6.2	2 07.9	7 9;	14 9;	21 8;	28 8				

Minima of Variable Stars of Short Period—Continued.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1919 April											
	h m	° ′		d h	d	h	d	h	d	h	d	h	d	h	d	h
U Coronae	15 14.1	+32 01	7.6— 8.7	3 10.9	1	14;	15	9;	22	7;	29	5				
TW Draconis	32.4	+64 14	7.3— 8.9	2 19.3	6	10;	14	20;	23	6;	28	21				
SS Librae	15 43.4	—15 14	9.3—11.5	0 18.4	1	19;	9	10;	17	2;	24	18				
SW Ophiuchi	16 11.1	— 6 44	9.2—10.0	2 10.7	3	16;	11	0;	18	8;	25	17				
SX Ophiuchi	12.6	— 6 25	10.5—11.2	2 01.5	2	9;	10	15;	18	21;	27	3				
R Arae	31.1	—56 48	6.8— 7.9	4 10.2	3	9;	12	5;	21	1;	29	22				
TT Herculis	16 49.9	+17 00	8.9— 9.3	20 18.1	6	2			17	3;	26	20				
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	4	1;	10	20;	17	15;	24	11				
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	0 20.1	5	0;	13	10;	21	19;	30	4				
u Herculis	13.6	+33 12	4.6— 5.4	2 01.2	4	16;	10	19;	23	3;	29	6				
TX Herculis	15.4	+42 00	8.3— 9.0	1 00.7	4	0;	11	5;	18	10;	25	15				
RV Ophiuchi	29.8	+ 7 19	9. —12	3 16.5	1	14;	8	23;	16	8;	23	17				
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	4	22;	13	2;	21	7;	29	11				
TX Scorpii	48.6	—34 13	7.5— 8.2	0 22.6	3	23;	11	12;	19	1;	26	14				
UX Herculis	49.7	+16 57	8.8—10.5	1 13.2	5	3;	12	20;	20	14;	28	8				
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8	1	2;	9	2;	17	1;	25	1				
WX Sagittae	53.6	—17 24	9.2—10.8	2 03.1	2	14;	11	3;	19	15;	28	4				
WY Sagittae	17 54.9	—23 1	9.5—10.6	4 16.0	9	8;	14	0;	18	16;	28	1				
SX Draconis	18 03.0	+58 23	9.3—10.5	5 04.1	4	17;	15	1;	25	8;	30	13				
RS Sagittarii	11.0	—34 08	5.9— 6.3	2 10.0	8	15;	15	21;	23	3;	30	9				
V Serpentis	11.1	—15 34	9.5—11.1	3 10.9	6	8;	13	6;	20	3;	27	1				
RZ Scuti	21.1	— 9 15	7.4— 8.3	15 03.2			11	13			26	16				
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	3	5;	10	8;	17	12;	24	16				
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	5	8;	12	11;	19	14;	26	16				
SX Sagittarii	39.7	—30 36	8.7— 9.8	2 01.8	3	9;	11	17;	20	0;	28	7				
RR Draconis	40.8	+62 34	9.3—13	2 19.9	5	16;	14	4;	22	16;	28	8				
RS Scuti	43.7	—10 21	9.3—10.3	0 15.9	5	13;	12	4;	18	20;	25	11				
β Lyrae	46.4	+33 15	3.4— 4.1	12 21.8	8	9			21	7						
U Scuti	18 48.9	—12 44	9.1— 9.6	0 22.9	8	14;	16	6;	23	21;	27	17				
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.4	8	9;	15	23;	23	13;	27	8				
RV Lyrae	12.5	+32 15	11. —12.8	3 14.4	8	6;	15	10;	22	15;	28	20				
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	7	22;	16	21;	25	19;	30	7				
U Sagittae	14.4	+19 26	6.5— 9.0	3 09.1	3	14;	10	8;	17	2;	23	21				
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	2	5;	9	14;	16	23;	24	8				
TT Lyrae	24.3	+41 30	9.4—11.6	5 05.8	7	1;	12	7;	22	19;	28	0				
UZ Draconis	26.1	+68 44	9.0— 9.8	1 15.1	5	13;	12	2;	18	14;	25	3				
SY Cygni	19 42.7	+32 28	10 —12	6 00.2	7	15;	13	15;	19	16;	25	16				
WW Cygni	20 00.6	+41 18	9.3—13.4	3 07.6	5	2;	11	17;	18	9;	25	0				
SW Cygni	03.8	+46 01	9. —11.7	4 13.8	4	10;	13	14;	22	17;	27	7				
VW Cygni	11.4	+34 12	9.8—11.8	8 10.3	6	23;	15	9;	23	20						
RW Capric.	12.2	—17 59	8.8—10.6	3 09.4	3	0;	16	14;	23	9;	30	4				
UW Cygni	19.6	+42 55	10.5—13	3 10.8	8	10;	15	7;	22	5;	29	19				
V Vulpec.	32.3	+26 15	8.2—9.8	37 19.0							30	22				
W Delphini	33.1	+17 56	9.4—12.1	4 19.4	3	16;	13	6;	22	21;	29	16				
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	2	10;	11	15;	20	19;	30	0				
Y Cygni	48.1	+34 17	7.1— 7.9	1 12.0	6	5;	13	16;	21	4;	28	16				
WZ Cygni	49.3	+38 27	9.9—10.8	0 14.0	2	20;	10	10;	18	9;	25	15				
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	5	23;	16	2;	21	3;	26	4				
VV Cygni	21 02.3	+45 23	12.1—13.8	1 11.4	7	5;	14	16;	22	0;	29	9				
AE Cygni	09.0	+30 20	10.8—11.4	0 23.3	3	15;	13	7;	23	0;	27	20				
RY Aquarii	14.8	—11 14	8.8—10.4	1 23.2	4	17;	12	14;	20	11;	28	8				
RT Lacertae	21 57.4	+43 24	9.1—10.5	5 01.7	3	2;	13	6;	23	9;	28	11				
UZ Cygni	55.2	+43 52	8.9—11.6	31 07.3			18	4								
RW Lacertae	22 40.6	+49 08	10.2—11.2	5 04.4	4	12;	14	21;	25	5;	30	10				
TT Androm.	23 08.7	+45 36	11.3—12.6	2 18.4	2	16;	10	23;	19	6;	27	13				
Y Piscium	29.3	+ 7 22	9.0—12.0	3 18.3	8	6;	15	18;	23	7;	30	20				
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	1	13;	9	19;	18	0;	26	6				

Maxima of Variable Stars of Short Period.

[Calculated by members of the class in General Astronomy at Carleton College.]

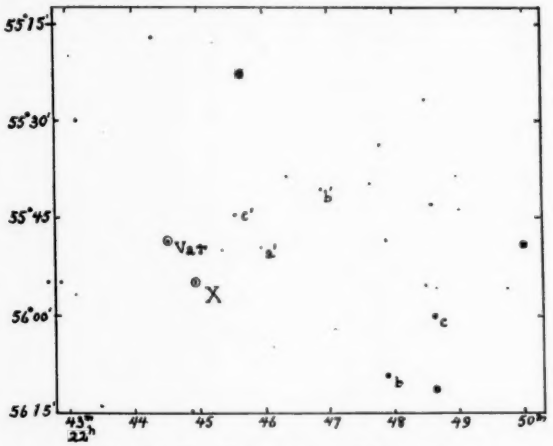
Given to the nearest hour in Greenwich mean time. To obtain Eastern standard time subtract 5^h; Central standard time 6^h; etc.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1919. April
	h m	° ′		d h	d h; d h; d h; d h; d h; d h
SX Cassiop.	0 05.5	+54 20	8.6— 9.2	36 13.7	
SY Cassiop.	0 09.8	+57 52	9.3— 9.9	4 1.7	5 18; 13 21; 22 0; 30 4
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	3 20; 11 14; 19 7; 27 1
RW Cassiop.	1 30.7	+57 15	8.9—11.0	14 19.2	1 2 15 22; 30 17
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	3 10; 11 9; 19 8; 27 6
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	5 13; 13 8; 21 4; 28 23
TU Persei	3 01.8	+52 49	11.4—12.2	0 14.6	4 7; 11 14; 18 20; 26 3
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0	16 0
SX Persei	4 10.2	+41 27	10.4—11.2	4 07.0	5 1; 9 8; 17 22; 26 12
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1	10 19; 21 22
RX Aurigae	4 54.5	+39 49	7.2— 8.1	11 15.0	10 5; 21 20
SX Aurigae	5 04.6	+42 02	8.0— 8.7	1 12.8	1 1; 8 17; 16 9; 24 1
SY Aurigae	05.5	+42 41	8.4— 9.5	10 03.3	1 9; 11 13; 21 16
Y Aurigae	21.5	+42 21	8.6— 9.6	3 20.6	1 10; 9 3; 16 20; 24 13
RZ Gemin.	5 56.6	+22 15	9.1—10.0	5 12.7	7 18; 13 6; 18 19; 24 8
RS Orionis	6 16.5	+14 44	8.2— 8.9	7 13.6	1 8; 8 22; 16 11; 24 1
T Monoc.	19.8	+ 7 08	5.7— 6.8	27 00.3	10 6
RT Aurigae	23.0	+30 33	5.1— 6.0	3 17.5	8 5; 15 16; 23 3; 30 14
RZ Camelop.	23.7	+67 06	11.0—13.0	0 11.5	5 14; 12 19; 19 24; 27 7
W Gemin.	29.2	+15 24	6.7— 7.5	7 22.0	4 3; 12 1; 19 23; 27 21
ξ Gemin.	6 58.2	+20 43	3.7— 4.3	10 03.7	4 12; 14 6 24 19
RU Camelop.	7 10.9	+69 51	8.5— 9.8	22 06.5	2 18 25 0
RR Gemin.	7 15.2	+31 04	10.0—11.5	0 09.5	2 14; 10 13; 18 11; 26 10
V Carinae	8 26.7	−59 47	7.4— 8.1	6 16.7	7 15; 14 8; 21 1; 27 17
T Velorum	8 34.4	−47 01	7.6— 8.5	4 15.3	6 19; 16 2; 20 17; 25 9
V Velorum	9 19.2	−55 32	7.5— 8.2	4 08.9	1 1; 9 19; 18 13; 27 7
Z Leonis	9 46.4	+27 22	7.9— 9.6	59 00.0	24 0
RR Leonis	10 02.1	+24 29	9.1—10.1	0 10.9	2 10; 9 5; 22 19; 29 14
SU Draconis	11 32.2	+67 53	8.9— 9.6	0 15.8	5 20; 12 10; 19 1; 25 15
S Muscae	12 07.4	−69 36	6.4— 7.3	9 15.8	10 11; 20 3; 29 19
SW Draconis	12.8	+70 04	8.8— 9.6	0 13.7	1 7; 9 7; 17 6; 25 5
T Crucis	15.9	−61 44	6.8— 7.6	6 17.6	7 18; 14 11; 21 5; 27 22
R Crucis	18.1	−61 04	6.8— 7.9	5 19.8	3 4; 8 24; 14 20; 26 11
S Crucis	12 48.4	−57 53	6.5— 7.6	4 16.6	3 9; 12 18; 17 11; 26 20
W Virginis	13 20.9	− 2 52	8.7—10.4	17 06.5	2 22 20 4
SS Hydrae	25.0	−23 08	7.4— 8.1	8 4.8	3 20; 12 0; 20 5; 28 10
RV Urs. Maj.	13 29.4	+54 31	9.2— 9.9	0 11.2	3 21; 10 22; 17 22; 24 23
ST Virginis	14 22.5	− 0 27	10.3—11.4	0 09.9	2 18; 10 23; 19 4; 27 9
V Centauri	25.4	−56 27	6.4— 7.8	5 11.9	8 18; 14 6; 25 6; 30 18
RS Bootis	29.3	+32 11	8.9—10.0	0 09.1	4 19; 12 8; 19 21; 27 11
RU Bootis	14 41.5	+23 44	12.8—14.3	0 11.9	3 5; 12 15; 20 1; 27 11
R Triang. Austr.	15 10.8	−66 08	6.7— 7.4	3 09.3	8 21; 15 15; 22 10; 29 5
S Triang. Austr.	15 52.2	−63 29	6.4— 7.4	6 07.8	5 17; 12 24; 18 8; 24 16
S Normae	16 10.6	−57 39	6.6— 7.6	9 18.1	2 6; 12 24; 21 18
RW Draconis	33.7	+58 03	9.6—10.8	0 10.6	9 23 17 24; 26 20
RV Scorpii	16 51.8	−33 27	6.7— 7.4	6 01.5	9 5; 15 6; 21 5; 27 9
X Sagittarii	17 41.3	−27 48	4.4— 5.0	7 00.3	3 19; 10 19; 17 20; 24 20
Y Ophiuchi	47.3	− 6 07	6.1— 6.5	17 02.9	16 12
W Sagittarii	17 58.6	−29 35	4.3— 5.1	7 14.3	7 5; 14 19; 22 9; 29 23
Y Sagittarii	18 15.5	−18 54	5.4— 6.2	5 18.6	7 18; 13 13; 19 7; 30 20
U Sagittarii	26.0	−19 12	6.5— 7.3	6 17.9	8 12; 15 6; 21 23; 28 17
Y Scuti	32.6	− 8 27	8.7— 9.2	10 08.3	10 20; 21 5
Y Lyrae	34 2	+43 52	11.3—12.3	0 12.1	2 23; 15 0; 21 1; 27 2
RZ Lyrae	39.9	+32 42	9.9—11.2	0 12.3	2 16; 14 22; 21 1; 27 5
RT Scuti	18 44.1	−10 30	9.1— 9.7	0 11.9	4 1; 15 23; 21 21; 27 20

Maxima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1919. April
	h m	° ′		d h	d h d h d h d h
κ Pavonis	18 46.6	—67 22	3.8— 5.2	9 02.2	8 3; 17 6 26 8
U Aquilae	19 24.0	— 7 15	6.2— 6.9	7 00.6	5 18; 12 19; 19 19; 26 20
XZ Cygni	30.4	+56 10	8.6— 9.3	0 11.2	8 22; 15 22; 22 22; 29 22
U Vulpec.	32.2	+20 07	6.5— 7.6	7 23.5	3 15; 11 14; 19 14; 27 13
SU Cygni	40.8	+29 01	6.2— 7.0	3 20.3	6 14; 14 6; 21 23; 29 15
η Aquilae	47.4	+ 0 45	3.7— 4.5	7 04.2	4 20; 12 0; 19 4; 26 9
S Sagittae	51.5	+16 22	5.6— 6.4	8 09.2	1 5; 9 14; 17 23; 26 8
X Vulpec.	19 53.3	+26 17	9.5—10.5	6 07.7	2 16; 15 7; 21 15; 27 23
X Cygni	20 39.5	+35 14	6.0— 7.0	16 09.3	4 17 21 3
T Vulpec.	47.2	+27 52	5.5— 6.1	4 10.5	2 5; 11 2; 19 23; 28 19
WY Cygni	52.3	+30 03	9.6—10.4	0 13.5	7 23; 14 17; 21 10; 28 4
RV Capric.	55.9	—15 37	9.2—10.1	0 10.7	4 21; 11 14; 18 7; 25 0
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4	15 12 30 5
VY Cygni	21 00.4	+39 34	8.8— 9.5	7 20.6	4 4; 19 11; 19 22; 27 18
SW Aquarii	10.2	— 0 20	9.9—10.8	0 11.0	7 10; 14 8; 21 5; 28 2
VZ Cygni	21 47.7	+42 40	8.2— 9.2	4 20.7	7 17; 12 13; 22 7; 27 4
Y Lacertae	22 05.2	+50 33	9.1— 9.6	4 07.8	4 15; 13 7; 21 22; 30 14
δ Cephei	25.5	+57 54	3.7— 4.6	5 08.8	4 15; 10 0; 20 18; 26 2
Z Lacertae	36.9	+56 18	8.2— 9.0	10 21.1	5 23 16 20; 27 17
RR Lacertae	37.5	+55 55	8.5— 9.2	6 10.1	5 8; 11 18; 18 4; 24 15
V Lacertae	44.5	+55 48	8.5— 9.5	4 23.6	4 18; 14 18; 24 17; 29 16
X Lacertae	22 45.0	+55 54	8.2— 8.6	5 10.7	4 13; 15 11; 20 21; 26 8
SW Cassiop.	23 03.7	+58 11	9.2— 9.7	5 10.6	3 10; 14 7; 25 4; 30 14
RS Cassiop.	32.6	+61 52	9.0—11.0	6 07.1	6 5; 12 12; 18 19; 25 3
RY Cassiop.	47.2	+58 11	9.3—11.8	12 03.4	4 22 17 2; 29 5
V Cephei	23 51.7	+82 38	6.0—7.0	0 23.9	5 19; 12 18; 19 18; 26 18

New Variable Star.—In *L'Astronomie* for December 1918 Mr. J. Ellsworth announces a new variable star in the field with the Cepheid variable X Lacertae.



Field of New Variable near X Lacertae.

It is the star BD. +55°2815, 7′ south and 15ˢ west of X Lacertae. The two stars are assigned the same magnitude, 8.7, in the BD. The accompanying chart shows

the BD. stars in the vicinity. Mr. Ellsworth gives the following sequence of reference stars with their estimated magnitudes:

c 7.3; *b* 8.0; *b'* 8.6; *c'* 8.9; *a'* 9.0

The observed range of brightness during October and November of 1918 was between magnitudes 7.7 and 9.4. The period is probably short.

NOTES FOR OBSERVERS.

Monthly Report of the American Association of Variable Star Observers, January, 1919.

It is a satisfaction to note the increase in the number of observations for January over those in December when the list was the shortest on record for several years.

Mr. C. Y. McAteer, who now has the use of the Association's 5-inch refractor, contributes an excellent report this month, which is especially valuable on account of the early morning observations. Valuable contributions of observations of the southern variables have been received from Professor Dawson of La Plata, and his associate, Senor Tapia, (designation Tp.)

The reprints of the observations for 1918 have been sent to all the members, and in case any member failed to receive a copy, please advise the acting secretary.

The publication of the retiring address of our first President has also been completed, and its distribution will enable each of our members to carefully peruse this valuable paper, and to act upon the suggestions contained as far as he is able to do so.

Attention is called to the excellent article on Variable Stars in *Science*, February 7, 1919, by Professor H. N. Russell, one of our honorary members.

SS Cygni, 213843, passed a well observed maximum of the anomalous type during the past month, and SS Aurigae, 060547, rose to maximum on February 2, two weeks ahead of its predicted date, after an interval of only thirty days between maxima. U Geminorum, 074922, has been faint since the middle of January and is not expected to be at maximum until some time in March. All of these interesting irregular variables need close attention, especially SS Cygni, which can be observed only just after sunset and before sunrise.

SU Tauri, 054319, which has been at full brightness for the past two years, needs careful watching to detect any decrease in light, which on previous occasions has usually been rapid and well marked.

Observers are cautioned not to use the 10.2 comparison star close to U Orionis, 054920, as it is now recognized as a variable, UW Orionis, 055020.

The following Maxima for March are cited from Harvard Circular 212:—

021281	Z Cephei	March 28	123160	T Urs. Maj.	March 13
022000	R Ceti	" 12	123307	R Virginis	" 30
032335	R Persei	" 30	*135908*	RR Virginis	" 14
044617	V Tauri	" 17	233956	Z Cassiop.	" 30

The subscript number of observer's initial indicates the number of observations by that observer included in the ten-day interval for which the mean date and magnitude are given.

Our Secretary is enjoying a well earned rest at Hot Springs, Arizona.

VARIABLE STAR OBSERVATIONS, January, 1919

December 0 = 2421928 January 0, 1919 = 2421959 February 0 = 2421990

001046
X Androm.

J.D. 242	Est.	Obs.
1978.6	8	Hu
85.7	9.4	M
86.5	8.5	B

001032
S Sculptoris

1890.7	9.0	Tp
92.6	9.3	δ
1900.6	8.9	Tp
01.6	9.0	Tp
21.6	8.5	Tp
21.6	8.6	δ
25.6	8.6	Tp
32.6	7.8	δ
34.6	8.0	Tp

001755
T Cassiop.

1984.5	9.0	B
85.7	9.5	M

001726
T Androm.

1986.5	12.1	B

001838
R Androm.

1978.6	11	Hu

001999
S Ceti

1960.3	<11.5	Pe

*002438*a
T Sculptoris

1892.6	13.0	δ
96.7	12.8	Tp
1900.6	12.8	Tp
00.6	12.9	δ
22.6	10.6	δ
25.6	10.5	Tp
32.6	10.5	δ
34.6	10.2	Tp

*002438*b
RR Sculptoris

1892.6	12.6	δ
96.7	12.7	Tp
1900.6	12.7	Tp
00.6	12.7	δ
24.6	12.7	δ
25.6	12.6	Tp
34.6	12.7	Tp

002546
T Phoenicis

1892.6	11.1	δ
1900.6	10.7	δ
01.1	10.6	Tp_2
21.6	9.5	Tp
30.1	9.0	Tp_2
32.6	9.0	δ

002833
W Sculptoris

J.D. 242	Est.	Obs.
1892.6	12.9	δ
1900.7	13.0	δ
02.6	13.0	Tp
32.6	13.0	δ
34.6	13.3	Tp

003179
Y Cephei

1978.6	12.6?	Hu

004047
U Cassiop.

1978.6	12.2	Wh
84.6	12.6	Y

004132
RW Androm.

1978.6	8.2	Hu

004435
V Androm.

1978.6	<12.6	Hu

004958
W Cassiop.

1978.6	10	Hu
78.6	10.2	Wh
81.5	9.7	B

011272
S Cassiop.

1984.5	11.5	B
85.7	11.7	M

011208
S Piscium.

1977.5	<13.0	Y

011712
U Piscium

1985.6	<12.6	Hu

012350
RZ Persei

1984.6	12.1	Y

012502
R Piscium

1977.5	12.5	Y

014958
X Cassiop.

1984.6	12.3	Y
85.7	12.5	M

015354
U Persei

1978.6	10	Hu
85.7	10.3	M

021024
R Arietis

1985.6	12.3	Hu

021281
Z Cephei

J.D. 242	Est.	Obs.
1987.6	<12.0	V

021403
o Ceti

1891.6	4.2	δ
1902.6	4.5	
37.3	6.9	Pe
54.3	7.1	
62.2	6.9	Mu_2
63.6	7.3	My
78.6	8.2	
85.6	7.7	Hu
88.0	8.6	My_3

022150
RR Persei

1984.6	10.4	Y

022813
U Ceti

1965.6	7.9	Y

023133
R Triang.

1967.6	8.6	Hu
86.5	6.9	B
91.7	5.7	M

024356
W Persei

1967.6	9.6	Hu
68.8	10.4	M
84.7	10.4	Mu

025751
T Horologii

1892.6	11.0	δ
1902.6	10.5	
02.6	10.3	Tp_2
22.6	9.2	δ
23.2	9.2	Tp
33.6	8.4	δ
34.6	8.5	Tp

030514
U Arietis

1984.6	12.6	Y

032043
Y Persei

1967.6	8	Hu
84.7	8.6	Mu
91.7	9.3	M

032335
R Persei

1967.6	12	Hu
91.7	12.5	M

033362
U Camelop.

1991.7	8.5	M

034124
S Fornacis

J.D. 242	Est.	Obs.
1892.6	8.8	δ
1932.7	8.7	

034625
U Eridani

1894.5	15.0	δ
1922.6	14.1	

035124
T Eridani

1892.6	7.8	δ
1902.6	7.6	
02.6	7.3	Tp
23.7	8.2	δ
24.6	8.1	Tp
32.6	8.5	δ
34.6	8.9	Tp

040725
W Eridani

1892.6	8.7	δ
1902.6	8.4	Tp
23.7	8.3	δ
24.6	8.7	Tp
30.6	8.6	Tp_2
32.6	8.7	δ

041619
T Tauri

1975.5	9.5	M

042215
W Tauri

1962.7	10.0	Mu
64.8	9.8	M
65.6	9.6	Y
67.6	8.9	Hu
78.6	9.2	Wh
81.5	9.5	B
87.6	9.8	M
91.7	9.6	M

042209
R Tauri

1964.8	11.2	M
67.6	9.9	Hu
78.6	9.0	Wh
84.5	9.4	Y
91.7	9.3	M

042309
S Tauri

1964.8	<12.5	M
84.5	<13	Y

043065
T Camelop.

1984.6	11.4	Y
85.7	10.7	M

043274
X Camelop.

J.D. 242	Est.	Obs.
1984.6	10.5	Y
85.6	10.5	Wh
85.7	11.5	M

043208
RX Tauri

1991.7	12.4	M

043263
R Reticuli

1892.6	10.3	δ
23.7	7.3	
24.6	7.5	Tp
32.7	7.5	δ

043562
R Doradus

1892.6	5.8	δ
1902.5	5.6	
23.7	5.9	
24.6	5.8	Tp

043738
R Caeli

1892.6	7.4	δ
1902.6	7.3	
02.6	7.5	Tp
23.7	7.5	δ
24.6	7.8	Tp
32.6	8.2	δ
34.6	8.4	Tp

044349
R Pictoris

1892.6	7.2	δ
1902.6	7.4	Tp
23.7	7.8	δ
24.6	7.8	Tp
32.6	7.9	δ
34.6	9.0	Tp

044617
V Tauri

1991.7	11.9	M

045307
R Orionis

1965.6	13.2	Y
77.5	13.2	

050003
V Orionis

1965.6	9.0	Y
77.6	9.8	
78.6	9.3	Wh
80.5	9.6	B
91.7	10.2	M

050022
T Leporis

1985.6	8.1	M
86.6	8.0	B

VARIABLE STAR OBSERVATIONS, January, 1919—Continued.

050953
R Aurigae
J.D. Est. Obs.
242
1970.8 8.6 M
88.5 8.4 V
88.5 8.2 Y

051247
T Pictoris
1892.7 10.8 δ
1902 6 11.9 Tp
23.7 13.1 δ
35.8 13.3

051533
T Columbae
1892.7 7.4 δ
1902.6 7.8
02.6 7.6 Tp
23.6 9.1 δ
26.6 9.0 Tp
35.8 10.3 δ

052034
S Aurigae
1962.7 9.7 Mu
70.8 9.5 M

052404
S Orionis
1975.6 9.4 M
84.5 10.2 Y
88.6 9.9 Hu

053068
S Camelop.
1984.5 9.3 Y
90.8 8.9 M

*053005*a
T Orionis
1978.6 10.5 Wh
81.5 9.9 B
84.7 10.4 Mu
85.6 9.4 M
88.6 10.9 Hu

053326
RR Tauri
1985.7 11.8 M

053531
U Aurigae
1968.8 8.5 M
79.5 9.1 Y
88.5 9.4 V

054319
SU Tauri
1965.6 9.3 Y
68.8 9.6 M
77.5 9.3 Y
78.6 9.5 Wh
83.0 9.5 B
85.6 9 Hu
86.5 9.5 B
88.6 9.4 V

054615a
Z Tauri
J D. Est. Obs.
242
1984.5<12.7 Y

054615b
RS Tauri
1984.5 9.0 Y

054615c
RU Tauri
1984.5 12.8 Y

054974
V Camelop.
1968.8 11.5 M
78.6 11.8 Wh
79.5 12.2 Y

054920
U Orionis
1967.6 11 Hu
68.8 11.0 M
86.5 11.9 B

055353
Z Aurigae
1968.8 10.4 M
88.5 10.5 Y

055686
R Octantis
1889.5 11.8 δ
1902.5 12.5
02.5 12.4 Tp
23.7 12.5 δ
35.8 12.7

060450
X Aurigae
1968.8 9.2 M

060547
SS Aurigae
1968.8<12.4 M
69.5<12.4 Y
85.6<13.3 M
88.5<13.3 Y

061647
V Aurigae
1970.8 10.6 M
88.5 10.5 Y

061702
V Monoc.
1985.7 11.7 M

063159
U Lyncis
1970.8 12.2 M
79.6 12.4 Y

063308
R Monoc.
J.D. Est.Obs.
242
1983.5 11.1 B
85.6 11.1 Wh
85.7 11.4 M

063558
S Lyncis
1970.8<12.6 M

064030
X Gemin.
1970.8 12.6 M
88.5 13.3 Y

064707
W Monoc.
1983.6 10.6 B
85 7 10.4 M

065111
Y Monoc.
1979.5 9.0 Y
83.5 9.0 B
88.6 8.9 V

065208
X Monoc.
1975.6 9.3 M

065355
R Lyncis
1979.6 12.4 Y

070122a
R Gemin.
1960.3 8.0 Pe
64.8 8.2 M
85.6 8.9 Hu
85.6 8.5 Wh

070122b
Z Gemin.
1960.3 12.2 Pe
64.8 12.7 M

070122c
TW Gemin.
1960.3 8.2 Pe
64.8 8.4 M

070109
V Can. Min.
1991.7 12.8 M

070310
R Can. Min.
1988.6 8.7 Hu

071044
L, Puppis
1892.7 4.3 δ
1902.6 4.6

072106
Nova Monoc.
J.D. Est.Obs.
242
1892.7 11.8 δ
1902.7 12.2
23.7 12.0
35.8 12.1

072708
S Can. Min.
1954.3 10.2 Pe
60.3 10.3
64.8 10.5 M
85.6 11.8 Wh

072811
T Can. Min.
1984.6<13.8 Y

073508
U Can. Min.
1979.6 12.4 Y
90.8 11.7 M

073723
S Gemin.
1978.6 11.9 Wh

074323
T Gemin.
1962.9 8.8 M
78.6 8.9 Wh
88.6 8.7 Hu
88.6 9.2 V

074922
U Gemin.
1962.9 9.5 M
63.9 9.9
64.8 10.3
68.8 11.9
69.8 12.8
70.9<13.0
77.5<13. Y
84.5<12.6 B
85.5<13.0 M
86.5<12.6 B
88.6<12.6 Hu
88.6<11.7 V
88.6<13.7 Y

075612
U Puppis
1984.6 10.4 Y
85.7 10.3 M

081112
R Cancri
1985.6 9.6 Wh
89.8 10.0 M

081617
V Cancri
J D. Est.Obs.
242
1985.6 7.6 Wh
89.8 7.6 M

083019
U Cancri
1989.8 10.7 M

083350
X Urs. Maj.
1989.8 12.6 M

084803
S Hydrae
1989.8 11.8 M

085008
T Hydrae
1989.8 7.8 M

085120
T Cancri
1985.6 9.4 Wh
89.8 10.2 M

090151
V Urs. Maj.
1954.3 10.3 Pe
60.3 10.3

090425
W Cancri
1989.8 13.0 M

091868
RW Carinae
1892.7 13.5 δ
1902.6 13.5

092962
R Carinae
1892.7 6.0 δ
1902.6 5.2
02.6 5.1 Tp
21.6 4.3 δ
21.6 4.3 Tp
22.6 4.6 δ
26.6 4.7
26.6 4.5 Tp
29.5 4.7 δ

093178
Y Draconis
1979.6 9.2 Y
88.6 8.9

093934
R Leo. Min.
1988.6 7. Hu
89.8 6.7 M

VARIABLE STAR OBSERVATIONS, January, 1919—Continued.

094023
RR Hydrae
J.D. Est. Obs.
242
1923.7 12.8 δ
35.8 12.6

094211
R Leonis
1968.9 10.2 M

094262
l Carinae
1902.6 3.4 δ
21.6 4.2
21.6 4.2 Tp

095421
V Leonis
1968.9 10.4 M

100537
R Antliae
1935.8 7.3 δ

100661
S Carinae
1892.7 6.6 δ
1902.6 6.3
02.6 6.1 Tp
22.6 5.9 δ
26.6 6.0 Tp
28.0 6.1 δ_2

103769
R Urs. Maj.
1962.9 12.0 M
85.7 11.0

104814
W Leonis
1968.9 10.4 M
79.6 10.4 Y

114441
X Centauri
1935.8 11.9 δ

120012
SU Virginis
1988.9 12.2 M

120905
T Virginis
1988.9 10.2 M

121418
R Corvi
1963.9 9.1 M

122001
SS Virginis
1963.9 8.0 M

122532
T Can. Ven.
1962.9 10.5 M

122803
Y Virginis
J.D. Est. Obs.
242
1963.9 10.8 M

123160
T Urs. Maj.
1960.3 10.0 Pe
62.9 9.5 M
65.6 9.0 Y

123307
R Virginis
1963.9 11.2 M

123459
RS Urs. Maj.
1962.9 11.9 M

123961
S Urs. Maj.
1960.3 8.3 Pe
62.9 8.5 M
65.6 8.6 Y
66.6 8.6 Pt

124606
U Virginis
1988.9 7.8 M

131283
U Octantis
1989.5 8.2 δ
1902.5 8.2
02.6 8.4 Tp
35.8 9.2 δ

132002
W Virginis
1988.9 9.6 M

132202
V Virginis
1988.9 8.5 M

132422
R Hydrae
1935.8 11.9 δ

133273
T Urs. Min.
1988.9 11.2 M

133633
T Centauri
1935.6 9.1 δ

134236
RT Centauri
1935.8 9.4 δ

134440
R Can. Ven.
1962.9 10.6 M
89.8 11.2

140528
RU Hydrae
J.D. Est. Obs.
242
1935.8 9.1 δ

140959
R Centauri
1889.5 6.9 δ
1935.8 7.2

141567
U Urs. Min.
1988.9 12.0 M

141954
S Bootis
1964.0 11.0 M

142584
R Camelop.
1988.9 12.6 M

142539
V Bootis
1763.9 10.2 M

143227
R Bootis
1963.9 8.0 M

144918
U Bootis
1968.9 11.4 M

145254
Y Lupi
1889.5 10.5 δ

151731
S Cor. Bor.
1963.9 6.7 M

151714
S Serpentis
1988.9 12.0 M

152849
R Normae
1889.5 9.3 δ

153378
S Urs. Min.
1990.8 8.5 M

153654
T Normae
1889.5 12.4 δ

154428
R Cor. Bor.
1963.9 6.4 M
88.9 6.0
89.9 6.0

154639
V Cor. Bor.
1963.9 7.4 M

154615
R Serpentis
J.D. Est. Obs.
242
1988.9 11.7 M

155018
RR Librae
1889.5 8.9 δ

160625
RU Herculis
1988.9 11.5 M

162119
U Herculis
1964.0 9.7 M

162112
V Ophiuchi
1889.5 8.3 δ

163172
R Urs. Min.
1963.9 9.1 M

163137
W Herculis
1988.9 11.8 M

163266
R Draconis
1963.9 8.0 M
69.5 8.5 Y
77.5 8.8

164055
S Draconis
1963.9 9.0 M

164844
RS Scorpii
1889.5 11.9 δ

165030
RR Scorpii
1889.5 9.8 δ

165631
RV Herculis
1989.0 10.8 M

172486
S Octantis
1889.5 10.4 δ
1902.5 10.9
02.6 10.7 Tp
23.7 12.0 δ
25.7 12.3 Tp
35.8 12.5 δ

*175458*a
T Draconis
1977.5 9.5 Y
88.9 9.8 M

*175458*b
UY Draconis
J.D. Est. Obs.
242
1977.5 10.8 Y
88.9 10.8 M

180363
R Pavonis
1889.5 13.1 δ
1902.5 13.0
26.5 12.1
32.5 11.2

180565
W Draconis
1990.9<12.0 M

182133
RV Sagittarii
1889.5 12.3 δ
1901.1 12.2 Tp_2
22.5 11.4 δ

183149
SV Draconis
1977.5 10.2 Y

184205
R Scuti
1889.5 5.4 δ
1902.5 5.3
32.2 6.4 Pe

184300
Nova Aquilae
1889.4 5.3 δ
1932.2 5.8 Pe

190529
V Lyrae
1977.5<10.7 Y

191033
RY Sagittarii
1891.0 7.0 δ_2
1902.3 6.8 Tp_4
02.5 6.7 δ
05.5 6.7 Tp
22.0 7.1 δ_2
23.3 6.9 Tp_3
32.5 7. δ

191124
TY Sagittarii
1889.5 11.6 δ
1902.5 12.1
02.6 12.2 Tp
05.5 12.0
22.5 13.0 δ
29.5 13.5

191350
TZ Cygni
1977.5 10.6 V

VARIABLE STAR OBSERVATIONS, January 1919—Continued.

193449
R Cygni

J.D. 242	Est.	Obs.
1957.5	8.6	V
61.5	9.3	Pt

193732

1963.6	7.2	Hu

193972
T Pavonis

1892.5	9.7	δ
1900.9	9.7	Tp_4
05.5	10.9	δ
05.5	11.0	Tp
21.6	12.3	
29.9	12.6	Tp_3
32.5	12.7	δ

194048
RT Cygni

1961.5	8.0	Pt
63.6	7.3	Hu

194348
TU Cygni

1957.5	9.9	V
63.6	10.5	Hu

194659
S Pavonis

1892.5	7.3	δ
1901.6	6.9	Tp_2
02.6	7.2	δ
05.5	6.7	Tp
21.6	7.2	
27.6	7.2	Tp_2
32.6	7.0	δ

194929
RR Sagittarii

1892.5	12.2	δ
1902.6	13.0	
02.6	12.6	Tp
22.5	13.4	δ
22.6	13.3	Tp
29.5	13.5	δ

195849
Z Cygni

1957.5	9.9	V

200647
SV Cygni

J.D. 242	Est.	Obs.
1962.6	9.6	Mu
63.6	8.8	Hu

201130
SX Cygni

1965.5	11.0	Y

201139
RT Sagittarii

1892.5	6.8	δ
1901.6	6.8	Tp_2
01.8	6.8	δ_2
21.6	7.4	Tp
21.6	7.4	
27.6	7.3	Tp_2
32.5	7.8	δ

201647
U Cygni

1960.3	9.9	Pe
62.6	9.6	Mu

202240
U Microscopii

1892.6	11.4	δ
1900.6	11.7	
01.1	11.7	Tp_2
21.6	12.7	δ
21.6	12.6	Tp
25.6	12.6	

202954
ST Cygni

1977.5	<13.	Y

202946
SZ Cygni

1963.6	9.4	Hu
78.6	10.2	Wh

203226
V Vulpeculae

1961.5	9.1	Pt

203816
S Delphini

1963.6	8.7	Hu

204846
RZ Cygni

1985.5	12.2	M

205627
RR Capricorni

J.D. 242	Est.	Obs.
1892.6	9.2	δ
99.6	9.2	Tp_3
1900.6	9.4	δ
21.6	10.5	
21.6	10.1	Tp
37.6	10.4	Tp_2

205923
R Vulpeculae

1963.6	8.8	Hu
85.5	12.0	M

210129
TW Cygni

1977.5	12.6	Y

210382
X Cephei

1988.6	13	Y

210868
T Cephei

1963.6	6.5	Hu

211614
X Pegasi

1977.5	10.3	Y

212030
S Microscopii

1892.6	9.5	δ
1900.6	10.1	
01.1	10.0	Tp_2
21.6	10.7	Tp
29.6	11.4	
32.6	12.1	δ

213678
S Cephei

1963.6	8.6	Hu

213753
RU Cygni

1985.5	8.1	M

213843
SS Cygni

1960.3	11.0	Me
62.6	<10.9	Mu
63.6	11.7	Hu
65.5	11.4	Y
75.5	11.5	
77.5	<11.3	V

SS Cygni

J.D. 242	Est.	Obs.
1978.6	11.3	Wh
81.5	8.9	B
83.5	8.8	B
84.5	9.0	B
84.5	9.2	Y
85.5	9.0	M
85.6	9.0	Wh
86.5	9.2	B
88.5	9.6	Y
88.6	9.7	Wh

213937
RV Cygni

1961.5	8.2	Pt
63.6	7.9	Hu
85.5	8.3	M

214247
R Gruis

1894.5	14.8	δ
1900.6	14.7	
22.6	14.5	
29.5	14.4	

220613
Y Pegasi

1986.5	9.3	B

220714
RS Pegasi

1986.5	11.6	B

221948
S Gruis

1892.6	12.2	δ
1900.6	12.4	
01.1	12.3	Tp_2
21.6	12.7	δ
21.6	12.8	Tp
27.6	12.7	Tp_2
32.6	12.9	δ

222439
S Lacertae

1978.6	8.1	Wh

223462
T Tucanae

1892.6	8.3	δ
99.6	8.3	Tp_3
1921.6	9.2	Tp
27.6	9.6	Tp_2
32.6	9.6	

225914
RW Pegasi

1962.6	11.1	Mu
77.5	11.7	Y
78.6	11.7	Wh

230110
R Pegasi

1960.3	10.3	Pe
62.6	9.9	Mu
77.5	8.9	Y
78.6	8.6	Hu
78.6	9.0	Wh

230759
V Cassiop.

1962.7	8.9	Mu
77.5	9.1	V
78.6	9.9	Hu
88.5	9.8	V

231425
W Pegasi

1978.6	9.3	Hu

231508
S Pegasi

1978.6	8.	Hu

232746
V Phoenicis

1893.6	13.6	δ_2
1900.6	14.0	δ
22.6	14.1	
29.5	14.0	

233335
ST Androm

1978.6	9.3	Hu

233815
R Aquarii

1961.5	8.4	Pt

235150
R Phoenicis

1893.6	13.6	δ_2
1900.6	13.7	δ
21.6	13.5	
21.6	13.3	Tp
32.6	13.0	δ
34.6	12.2	Tp

235350
R Cassiop.

1988.5	<11.4	V

235939
SV Androm.

1977.5	8.5	Y
78.6	8.2	Hu

No. of Observations 608; No. of Stars Observed 223; No. of Observers 12.

The following members contributed to this report: Messrs. Bouton, Dawson, Hunter, McAteer, Mundt, Murray, Peltier, de Perrot, Tapia, Vrooman, Whitehorn, Miss Young.

IDA E. WOODS,
Acting Secretary.

COMET AND ASTEROID NOTES.

Ephemeris of Borrelly's Comet 1905 II by M. G. Fayet.

[From Circular No. 115 of the Observatory of Marseilles.]

Gr. Midn.	α App.	δ App.	log r	log Δ	$\frac{1}{r^2\Delta^2}$
	h m s	° ′			
Mar. 2	7 09 33	+63 56			
4	13 40	63 37			
6	17 51	63 17	0.26483	0.09827	0.188
8	22 06	62 56			
10	26 25	62 34			
12	30 48	62 12			
14	35 13	61 49	0.27717	0.13347	0.151
16	39 40	61 25			
18	44 07	61 01			
20	48 35	60 36			
22	53 03	60 10	0.28939	0.16706	0.122
24	7 57 31	59 44			
26	8 01 59	59 17			
28	06 27	58 50			
30	10 54	58 22	0.30146	0.19918	0.100
Apr. 1	15 21	57 54			
3	19 46	57 26			
5	24 09	56 57			
7	28 31	56 28	0.31333	0.22992	0.082
9	32 52	55 58			
11	37 11	55 28			
13	41 27	54 58			
15	45 42	54 28	0.32496	0.25932	0.068
17	49 55	53 57			
19	54 06	53 26			
21	8 58 14	52 55			
23	9 02 21	52 24	0.33635	0.28748	0.057
25	06 26	51 53			
27	10 29	51 21			
29	14 30	50 49			
May 1	18 29	50 18	0.34748	0.31443	0.047
3	22 27	49 46			
5	26 22	49 14			
7	30 15	48 42			
9	9 34 04	+48 10	0.35834	0.34020	0.040

Elements of Comet *a* 1918 (Reid).—Mr. William Reid, the discoverer of the first new comet of 1918, on June 11, has written us under date December 21, 1918, communicating the following elements of his comet. The first set of elements was calculated by Dr. Halm, of the Royal Observatory, Cape of Good Hope, from three poor observations; the second set by Mr. H. E. Wood of the Union Observatory, from three good observations on dates June 13, 16 and 19.

Mr. Reid is an amateur, living about three miles from the Cape Observatory, and is director of the Comet Section of the Cape Astronomical Association. His telescope has a 6-inch Cooke object-glass. He writes: "At discovery the comet was about eighth magnitude, a small hazy patch, with slight central condensation. It rapidly got fainter and disappeared at the beginning of August. It was photographed about a dozen times at the Royal Observatory and no doubt they will have something to say about it later on."

ELEMENTS OF COMET *a* 1919 (REID).

By Dr. Halm	By H. E. Wood
T = 1918 May 30.512	1918 June 5.275 G. M. T.
ω = 185° 55′.3	194° 07′ 18″ }
Ω = 20 50 .3	17 49 28 } 1918.0
i = 75 05 .6	70 08 41 }
log. q = 0.03196	0.04194
q = 1.0764	1.1014

Representation of mean place:
O—C, $\Delta\alpha$ −11″, $\Delta\delta$ 0″.

Wolf's Periodic Comet.—In the *Astronomical Journal* No. 746 Mr. Kamensky gives the following elements of Wolf's comet, corrected for the perturbations by Earth, Mars, Jupiter and Saturn up to December 16, 1918:

December 16.0, 1918, Berlin M. T.

M	=	0°	22′	02″.50	
ϕ	=	33	57	56 .58	
Ω	= 206	41	53	.36 }	
π	= 19	38	01	.44 }	1919.0
i	= 25	17	29	.65 }	
μ	= 552″.71793				

The correction to the ephemeris based an these elements, according Barnard's observation on September 26, 1918, was

Sept. 26.73 $\Delta\alpha \cos\delta = -6^s.30$ $\Delta\delta = -31''.7$.

The comet has been extremely faint at this apparition, so that it is a difficult object.

EPHEMERIS OF WOLF'S COMET.

[By M. Kamensky. From the *Astronomical Journal* No. 746.]

Berlin Noon	α	δ	log r	log Δ	Aberration Time
	h m s	° ′ ″			m s
Mar. 2	2 24 10.0	+1 08 53	0.2474	0.3329	17 53
6	34 24.1	1 35 19	0.2517	0.8417	18 15
10	44 33.6	2 01 15	0.2561	0.3504	18 37
14	2 54 38.5	2 26 30	0.2606	0.3589	18 59
18	3 04 38.7	2 50 59	0.2651	0.3673	19 21
22	14 34.3	3 14 33	0.2698	0.3756	19 43
26	24 25.3	3 37 06	0.2744	0.3837	20 06
30	34 11.9	3 58 29	0.2791	0.3917	20 28
Apr. 3	43 53.9	4 18 38	0.2839	0.3995	20 51
7	3 53 31.3	4 37 25	0.2887	0.4071	21 13
11	4 03 04.2	4 54 47	0.2935	0.4147	21 35
15	12 32.0	5 10 39	0.2983	0.4220	21 57
19	21 55.1	5 25 00	0.3031	0.4292	22 19
23	31 13.3	5 37 46	0.3080	0.4363	22 41
27	40 26.6	5 48 54	0.3128	0.4432	23 03
May 1	4 49 34.9	+5 58 22	0.3176	0.4499	23 25

COMMUNICATIONS.

A Curious Meteor.—On the 19th of December I saw a very peculiar meteor. The northern and western sky was covered by light Cirrus clouds, while to the east there was a very heavy cloud bank from the horizon to about 35° high. Jupiter was dimly visible through the clouds, when at 6^h 59^m p. m. the meteor appeared, azimuth 170°, altitude about 80°. It moved in a direction east northeast and disappeared at a point in azimuth about 220; altitude 30°. It was brighter than Venus at its brightest and had a short bright tail of a yellow greenish tint. Duration 3½ seconds. The peculiarity of this meteor was that it came out of the clouds and disappeared again in the clouds; the length of the path was about 40 degrees.

H. R. KARSTENS.

Nutana, Sask, January 28, 1919.

The Distances of the Stars.—I have been interested recently in looking into some of the facts concerning the midwinter stars.

This has been prompted by the unusual opportunity afforded by the extraordinary weather conditions for studying the heavens this winter. There has been nothing like it for at least a decade. Night after night the amazing group of suns that bespangle the heavens from the Pleiades to Arcturus, have sparkled with unabated brilliancy. It seems incredible that anyone with eyes to see, can avoid the compelling attraction of these celestial wonders.

It is, however, somewhat disconcerting to note the serious disagreements which exist about the distances of these stars. For instance, in Circular number 205 issued by Harvard College Observatory, the distance of the Great Nebula in Orion is given by W. H. Pickering as 2000 parsecs or 6520 light years. As against this the average distance of the Nebula group, which includes the Orion Nebula, is given by Professor Kapteyn as 600 light years. Surely there must be some serious error here for even in astronomy a difference in estimates which involves the huge distance implied by nearly 6000 light years can scarcely be waved aside as negligible.

Again W. H. Pickering has said that Rigel is 2,100,000 times brighter than the sun. Professor Kapteyn deduces from his recent studies that this star is 12,000 times brighter than the sun. Some difference! Professor Russell's comment on Professor Kapteyn's estimate is that it makes Rigel the brightest star of which we have definite knowledge, notwithstanding the researches of Gill and Elkin which claim for Canopus a brilliancy 22,000 times greater than the sun.

The average reader is unhappily led by these widely diverging conclusions, to believe that there is no reliable method yet discovered for determining the distances and brilliancy of the most remote stars.

S. C. HUNTER.

GENERAL NOTES.

Dr. H. E. Lau of the Urania Observatory, Copenhagen, Denmark, died on September 29, 1918, a victim of the influenza which has ravaged so much of the world in the past few months. He was 39 years old and had been interested in astronomy from the age of 16. He was one of the "Associated Observers of Mars,' and has published studies in various lines of astronomy.

Rev. E. W. Etzel, professor of astronomy and mathematics at St. Thomas College, St. Paul, Minnesota, died on February 3 of erysipelas. Father Etzel was a Fellow of the Astronomical Society of London and had degrees from several continental universities. He came from France eight years ago.

He was the mathematics teacher of General Petain, famous French military strategist, when the latter was a boy at Besancon, France.

Edward C. Pickering.—All astronomers will mourn the loss of Professor Edward Charles Pickering, the distinguished director of Harvard College Observatory. His death occurred on February 3, 1919, in the seventy-third year of his age. He was one of the best known and most esteemed astronomers in the world.

Our readers will be especially interested in the account of his life given in this number of POPULAR ASTRONOMY by Miss Annie J. Cannon.

From newspaper clippings which have been sent to us we take the following memoranda, which are not touched upon in Miss Cannon's account.

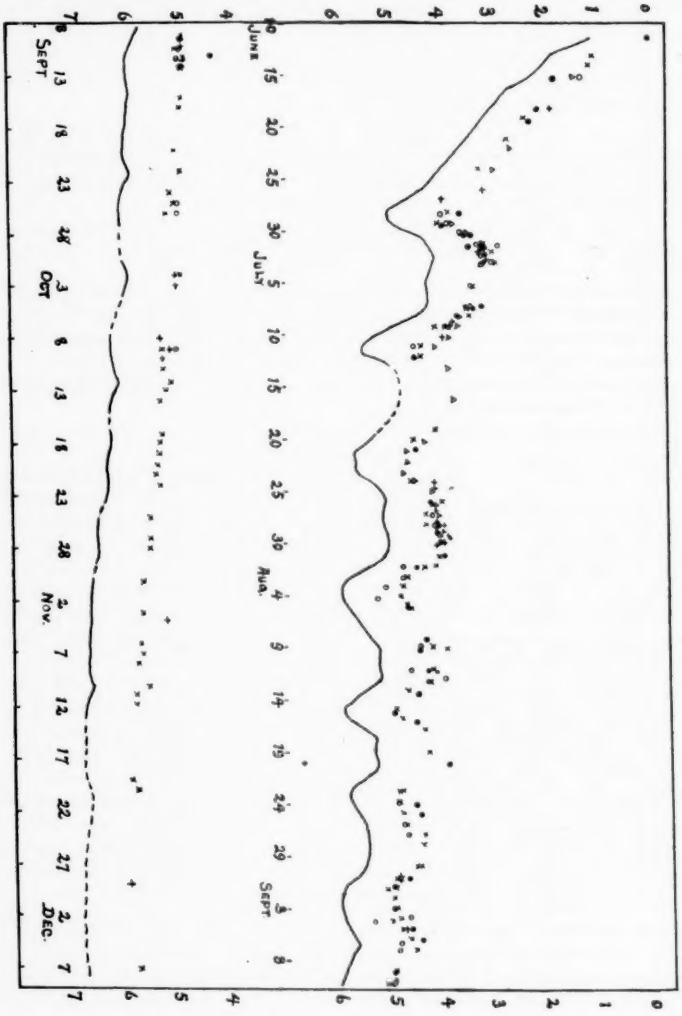
He was taken ill on Friday January 24 with pneumonia and this, combined with an attack of heart disease, proved fatal in ten days. The funeral services were held in Appleton Chapel on February 6. The services were conducted by Rev. Joel H. Metcalf, of Winchester, Mass., himself an astronomer of note and a friend of Professor Pickering. The following were the honorary pall bearers: President A. Lawrence Lowell, Dr. Charles W. Eliot, Dr. H. P. Walcott, Professor Charles R. Cross of the Institute of Technology, Professor Otto Klotz, director of the Dominion Astronomical Observatory at Ottawa, Canada; Professor Solon I. Bailey of the Harvard College Observatory; Charles P. Bowditch, Professor Elihu Thomson, Professor Ernest W. Brown of Yale University, and Professor Edwin H. Hall of the department of physics at Harvard, who was in charge of the arrangements.

In an editorial in "The Christian Science Monitor" February 6 are these remarks: "Great inheritances in wealth, as well as in moral and intellectual riches, came to Professor Pickering and enabled him to proceed with his favorite studies in a large and leisurely way. He turned back to Harvard annually the amount which he received in salary as director of the observatory, with a considerable addition to the gift drawn from his own pocket. Modesty was one of his marked traits. He preferred above all things to carry on his researches quietly. Rather did he discourage than court recognition of his notable acomplishments."

The Double Stars Σ 208 and Σ 1834.—In the *Astronomical Journal* No. 746, Professor Eric Doolittle discusses the motions of these two double stars, and concludes that both are binary stars, but that the orbits cannot yet be computed. He gives the following short ephemerides and says that observations of these stars are now of special importance.

	Σ 208, 10 *Arietis*		Σ 1834	
	θ	ρ	θ	ρ
	°	″	°	″
1918.0	110.70	0.64	284.69	0.54
1920.0	115.19	0.65	285.53	0.65
1922.0	119.48	0.67	286.14	0.75

Nova Aquilae, No. 3.—The sun has become so near to Nova Aquilae No. 3 that observation must be stopped for a time. It seems, therefore, to be desirable



PRELIMINARY LIGHT CURVE OF NOVA AQUILAE NO. 3, FROM 527 OBSERVATIONS, PLOTTED BY I. YAMAMOTO.

now to collect the materials of magnitude-estimations and to obtain a provisional light-curve therefrom, which should be the most convenient and effective guide to the general investigation of physical changes in the activity of the star. Unfortunately

I am too far from "western" collaborators to get their data, so that I must be satisfied, for the present, with those of a few observers in my native country. For my hasty examination of the general "Nova"-life I have found these almost sufficient in their consistent results. The materials here used are summarized in the following short table:

Symbol used in the curve	Observer's Name	No. of Observations	No. of mean values taken	No. of Nights
●	I. Yamamoto	80	38	38
○	Y. Ueta	42	36	35
×	K. Kudara	250	103	94
Δ	K. Sekiguti	102	29	23
+	T Sasaki	53	32	28
	Total	527	238	

Earlier parts of the first three persons' data are found in POPULAR ASTRONOMY November 1918, the rest being not yet published. Dr. Sekiguti's observations are in *Temmon geppoo* (Astronomical Herald, published monthly by the Nippon Astronomical Society) July to September 1918. Mr. Sasaki's observations were communicated in letters from him to the writer.

All of the observations were made by Argelander's method, referring to the Harvard System for the magnitudes of the comparison stars, and to Greenwich mean time for dates.

All of the mean magnitudes were plotted on cross-section paper and a probable smooth curve drawn through them. Precautions were taken to make the curve run as nearly parallel as possible to the time-gradients, by making straight-line connections between every two or three consecutive points for individual observers separately. We see in the curve that the moon's position had a considerable effect in decreasing the number of observations, each of which is very valuable for us; it is very much to be regretted in this connection that the maximum phase in the middle of July is too poor in materials to connect them in a curve.

To speak generally of the nature of the light-curve, the amplitudes of somewhat periodic variations are of shorter duration in the point of repetitions as compared with those of Nova Persei No. 2 of 1901, and the damping off of the ranges seems more rapid. These facts, it seems to me, will not be improved to any great extent by accumulating more materials, which the spectroscopic transformations will confirm too. The next peculiarity of this light-curve is that the several maxima show at each summit a perceptible secondary minimum, or at least a constant phase of magnitude of a few days' duration. The exceptions, if any, are in two cases, viz. in the middle of July and at the end of August. Both of these, however, are due to the scarceness of materials and may agree with the others when the data are supplemented by many other observations not now at hand. Moreover I have found quite similar phenomena in two cases of minimum phase, the one being at the point July 21-22 (the data are very poor and should be supplemented by others), and the other seen from the data of foreign observers at the epoch of August 13-15, which are not used in my provisional curve and therefore not shown, but will be published in the near future in a more or less definitive curve, which includes many other available data and is now in course of reduction in my hand. In the accompanying diagram, the ordinate scale of the smooth curve is displaced *one step down* to avoid confusion with the plotted points.

I. YAMAMOTO.

Kyoto University Observatory,
December 24, 1918.

Measurements of Gravity.—The report of the International Geodetic Association, recently published, states that since the last general report on gravity determinations in the Comptes-Rendus de la XVII Conférence générale the central office of the Association has received notice of pendulum observations made at about 300 new stations, for 167 of which definite results have been published. The largest number of these determinations have been made in the United States. The total number of stations in the international system of gravity measurements now amounts to 3,200. (*Scientific American*, February 22, 1919.)

TO THE SPECTROSCOPE.

One day untiring Science, treading slow
The narrow shores of Truth's unbounded sea,
A crystal found and gave it unto man,
His pupil. He in the sun admiring it,
Was glad, for lo the light in fragments lay
Full matching, hue by hue, the arch which God
Hath hung in storm-tossed skies, as earnest sure
Of changeless purpose not to whelm the world
Again with floods, as in the days of eld.
Then *thou* didst come, as did the Afrit huge
In Arab tale, the mightiest spirit of great
Accomplishment vouchsafed to man, his will
To do. Thou shewest why both star and flower
And sky and field their thousand-tinted robes
Display, and why the gem its beauty wears.
The inmost secrets of the elements,
Thru thee are traced in earth and distant star;
The mystic dance of ions stands revealed;
And e'en the amazing flight of unleashed sun
Or universe athwart the eternities,
The meteor's flash, the comet's dash, are timed
By thee. Thou leadest man to mangered star,
Close wrapped in nebulous swaddling clothes, and new-
Born element, just travailed by radio-force.
Thou knowest the hidden paths of binary stars,
The ceaseless whirl of unseen worlds, the forge
Where heavenly spheres are shaped; and man
Thru thee may see and grasp the infinities.
There's naught too high, and naught too low, the near
And far are alike to thee. Tho chained to earth
Is prisoned flesh, the mind of man may roam
With thee thru heights of Heaven and nether depths.
Jehovah doth reveal thru thee his deeds
And plans. And now abideth Microscope
And Telescope, and thou, oh Spectroscope—
These three great servitors of thot and man—
The greatest of these spirits three art thou.

WILBUR FRANKLIN HOYT.

Peru, Nebraska.